THE DENTAL PRACTITIONER

AND DENTAL RECORD

Including the Transactions of the British Society for the Study of Orthodontics, and the official reports of the British Society of Periodontology, the Glasgow Odontological Society, the Liverpool and District Odontological Society, the North Staffordshire Society of Dental Surgeons, the Odonto-chirurgical Society of Scotland, and the Dental and Medical Society for the Study of Hypnosis

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THE DENTAL PRACTITIONER

AND DENTAL RECORD

Vol. IX, *No.* 1 *September*, 1958

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THE DENTAL PRACTITIONER AND DENTAL RECORD

Vol. IX, No. 1 September, 1958

EDITORIAL

TEN YEARS

NOBODY can deny the great benefits which the National Health Service has brought to all kinds and conditions of people, making the greatest surgical and medical skills in the land available to all, regardless of financial consideration. There are those who dispute the wisdom of removing all financial liability from the patient and indeed not without justification, particularly as it affects dental treatment; others are firmly and even passionately convinced that the service should be completely free. Be that as it may, the introduction of charges in the General Dental Service was an effective, if rather rough-and-ready means of curtailing the excessively heavy demand for treatment and helping to rationalize the position of the grossly overworked dentist.

Relations between the profession and the Ministry have been marred by arbitrary reductions of the scale of fees, which at one stage amounted to the imposition of a discriminating tax on one section of the community. The unfortunate publicity resulting from this had without doubt an adverse effect on recruitment to the Dental Schools. Great credit is due to the patience and wisdom of our professional representatives for the success which they have achieved in their negotiations, which have resulted in as workable a compromise as could be hoped for under a Scale of Fees system.

There has also been an increase in the provision of consultant dental services, although there is still room for further improvement. The introduction of higher degrees and diplomas by the Universities and licensing authorities provides an incentive to the newly qualified dental surgeon to continue with post-graduate studies, leading ultimately to the attainment of Consultant status.

In the field of research many new techniques have enabled workers to make fundamental investigations which have added particularly to knowledge of micropathological problems involved in the aetiology of dental disease.

Perhaps the most significant development in the past ten years has been the attainment by the profession of full maturity with the emergence of the General Dental Council. Now that we have full control of our own affairs we may confidently hope that the next decade will carry us farther on the path towards the ultimate elimination of dental disease.

CHANGE IN THE JOURNAL CONTENTS

In view of the large amount of material in the possession of the British Society for the Study of Orthodontics, it has been decided to devote a special section of the Journal to the transactions of the Society. The cost of this section will be partly met by the Society. It is emphasized that the rest of the Journal will remain the same and any additional articles on Orthodontics will mean the enlargement of the Journal and not the reduction in practical articles on other aspects of Dentistry.

A PRELIMINARY INVESTIGATION OF THE SUPPORT OF PARTIAL DENTURES AND ITS RELATIONSHIP TO VERTICAL LOADS*

By **D. M. WATT, A. R. MacGREGOR, M. GEDDES, A. COCKBURN,** and **J. L. BOYD**

Prosthetic Department, School of Dental Surgery, University of Edinburgh

THERE are two important factors which must be assessed before designing a partial denture: (1) The loads to which the denture will be subjected; (2) The support offered by the oral structures to those loads.

The denture can then be designed to ensure efficient distribution of the loads on the support available.

In our study of load and support we have restricted ourselves to vertical loads and the support offered by teeth and tissue to those loads. We have made no attempt to study the more complex lateral loads to which partial dentures are subjected. Another point worth stressing is that our study of biting loads covers a relatively small group of students and patients so that any conclusions which we draw must be tentative.

VERTICAL LOADS ON PARTIAL DENTURES

It is probably safe to assume that the greatest loads to which partial dentures are subjected are applied in a direction normal to the occlusal plane. We can conveniently divide these loads into two groups: (1) Masticatory loads; (2) Clenched loads.

1. Masticatory Loads.—Masticatory loads may be defined as the forces applied to a denture and its support during mastication. They will vary with the type of food, the occlusal surface area of the teeth, and, to a certain extent, other factors, which will be mentioned later, will also affect the magnitude of these loads. We have not attempted to measure these loads.

The data at present available on masticatory loads are fairly limited, the work of Anderson (1953, 1956), Howell and Manly (1948), and Yurkstas and Curby (1953) being best known.

* A paper read before the British Society for the Study of Prosthetic Dentistry, April, 1957.

Table I summarizes some of their findings and shows the masticatory loads.

Table I.—MASTICATORY LOADS

Full Dentures (Yurkstas and Curby)
(Strain gauge in premolar)

Greatest recorded load	12 kg.
Common maximum loads	6–8 kg.
Average loads for most foods	0·3–1·8 kg.

Natural Teeth (Anderson)
(Strain gauge in inlay)

Maximum Whole Tooth Loads from 20 Sequences

Subject 1	Biscuit	14·9 kg.
	Carrot	13·7 kg.
	Meat	7·2 kg.
Subject 2	Biscuit	11·4 kg.
	Carrot	12·0 kg.
	Meat	11·6 kg.

2. Clenched Loads.—The second type of vertical load we have called the clenched load. It is the load applied to the denture and its support when the patient clenches his teeth. It may be thought of as the vertical component of bruxism loads—which the periodontologists tell us are most damaging to the supporting structures (Miller and Firestone, 1947; Leof, 1944). In any event, since it is the greatest vertical load to which partial dentures are subjected we thought it worth studying.

Over the years since 1861 data have been published on biting force (*Table II*). This force is equivalent to the clenched load, although it may be slightly less since a certain amount of jaw separation is necessary to allow for the insertion of the bite load gauge between the teeth. *Table II* shows that there is a large variation in these loads and, apparently, the load depends a good deal on the individual who measures it and the equipment he uses.

The loads in *Table II* are arranged in order of magnitude. It is of interest to note that the names of Dennis, Haber, and Dietz

appear in the same order in each group of measurements. The range of measurements appeared to be so great that we were tempted to carry out experiments to find if we could eliminate some of the variables which control bite loads (O'Rourke, 1949). The instrument we used for the measurement of bite load is illustrated in *Fig.* 1. It works on the torsion-bar principle.

Table II.—Bite Loads

Natural Teeth	
Incisors	
7–12·5 kg.	Dennis (1894)
15 kg.	Morelli (1920)
20 kg.	Schulze (1921)
15–25 kg. (average), 58 kg. (maximum)	Haber (1926)
30 kg.	Dietz (1920)
20–40 kg.	Eckermann (1911)
40–50 kg.	Rosenthal (1895)
Canine	
22–36 kg. (average), 86 kg. (maximum)	Haber (1926)
Premolars	
11·3–18 kg.	Dennis (1894)
26–40 kg. (average), 110 kg. (maximum)	Haber (1926)
50 kg.	Dietz (1920)
Molars	
14·5–21·5 kg.	Dennis (1894)
36–72 kg. (average), 120 kg. (maximum)	Haber (1926)
40–80 kg.	Eckermann (1911)
90 kg. (maximum)	Howell and Manly (1948)
100 kg.	Dietz (1920)
Single Natural Teeth (Unspecified)	
11–125 kg., 77·7 kg. (average)	Black (1895)
7–21·5 kg.	Dennis (1894)
20–80 kg.	Eckermann (1911)
15–120 kg.	Haber (1926)
Total	
50–125 kg.	Hauptmeyer (1920)
113·4 kg.	Dennis (1894)
225 kg.	Burras (1861)
224 kg. (Females)–352 kg. (Males), (averages)	Haber (1926)
Full Dentures	
9–13·5 kg.	Black (1895)
1·1–4·5 kg.	Dennis (1894)
20–25 kg.	Reschofsky (1906)
Partial Dentures	
18–36 kg. (partial upper)	Black (1895)
5 kg. (bridge)	Etling (1921)

The factors which we considered would most affect the load were as follows:—

1. The musculature of the patient. This we related to height and weight.

2. The pain and discomfort thresholds of the patient—this we related to a thumb test. The base of the thumb nail was pressed with the instrument shown in *Fig.* 2, and the patient was asked to indicate when he experienced discomfort and when the discomfort became pain. Readings of the applied pressures in kilograms represented discomfort and pain thresholds. Attempts at similar measurements in the mouth proved to be unsatisfactory since the load was limited by the patient's expectation of the pain or discomfort which he experienced on release of the biting load.

3. The inclination factor of the patient—that is his willingness or inclination to co-operate. This we related to his ability to raise a column of mercury in a mercury manometer.

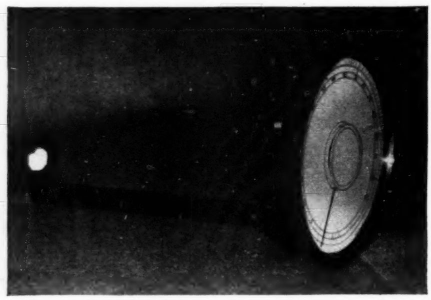

Fig. 1.—Bite load gauge. The patient bites on the rubber-padded arms (*left*). A torsion bar runs from these to the dial which records the load in kilograms.

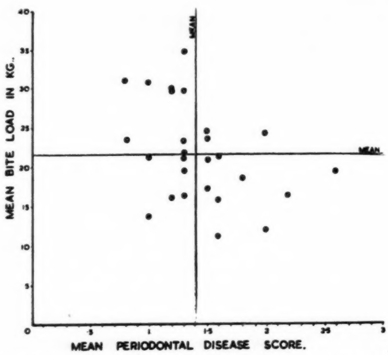

Fig. 3.—The mean bite load of each patient is plotted against his mean periodontal disease score. The crossed lines in the centre of the scatter diagram represent the mean bite load and P.D.S. for the whole group, having values of 21·7 kg. and 1·4 kg. respectively.

4. The health of the teeth and their supporting structures. This we assessed by a periodontal disease scoring method which was based on one designed by A. L. Russell (1956) but was very much simplified to make it more easily and quickly applicable. Our periodontal disease scoring method is illustrated in *Table III*.

Having placed the tooth in one of the groups above, a figure is added after a point to indicate the depth of the deepest pocket in millimetres.

For example, a tooth with a periodontal disease score of 2·3 would show gingivitis and fremitus and the greatest depth of pocket round the tooth would be 3 mm.

Fig. 2.—Method of recording pain and discomfort thresholds.

The scatter diagram in *Fig.* 3 is the result of plotting the average biting load of each patient against his average periodontal score.

At first glance this shows as much trend as the currants in a plum-duff, but if we examine the means we find that the bite force tends to drop as the amount of periodontal disease increases.

We expected a better correlation and we decided that we should take the other variables

Table III.—Periodontal Disease Scoring Method

	Score
No gingivitis, no fremitus on percussion	0
Gingivitis, no fremitus on percussion	1
Gingivitis and fremitus on percussion	2
Visible mobility	3

into consideration. So we worked out a compensation factor based on the difference between the mean and the individual scores for each of the variables (height and weight, pain threshold, blowing pressure, etc.). This compensation factor we applied to the bite force with the result shown in *Fig.* 4. This shows a better trend, but perhaps our less kind readers might suggest that whether or not the currants in a plum-duff show trend entirely depends on who cooks it! It may also indicate that the biometric measurements which we took have some influence on the biting load since the trend improves.

The bite force on individual teeth plotted against the periodontal disease score (P.D.S.) for these teeth showed an inverse relationship for incisors and molars (*Fig.* 5). Here is seen a definite decrease in the mean bite force as the P.D.S. increases. Unfortunately, the range of measurements for each tooth is so great that no conclusions can be drawn as far as individual cases are concerned.

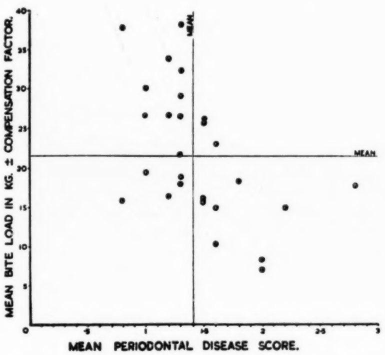

Fig. 4.—Scatter diagram showing improved trend (cf. *Fig.* 3) produced by applying the compensation factor.

Canines did not show this trend so well, but we attributed this to the fact that their sharp cusps penetrated the rubber padding on the instrument. The result was a reduction of the force owing to the uncomfortable tooth-to-metal contact and the fear of the instrument slipping and fracturing a cusp.

It is obvious that much more work will have to be done on these lines before we can draw any worthwhile conclusions. The number of factors which affect the clenched load in any individual are too numerous to control. To illustrate this a quotation from *Alice's Adventures in Wonderland* (Carroll, 1865) would seem to be appropriate:—

> 'In my youth,' said his Father, 'I took to the Law,
> and argued each case with my wife.
> And the muscular strength which it gave to my jaw,
> has lasted the rest of my life.'

However, our results may be summarized thus:—

1. We could not prove a relationship between bite force, height and weight, blowing pressure, and pain threshold by thumb test, although there might possibly be one, since the compensation factor, which included all these variables, improved the trend.

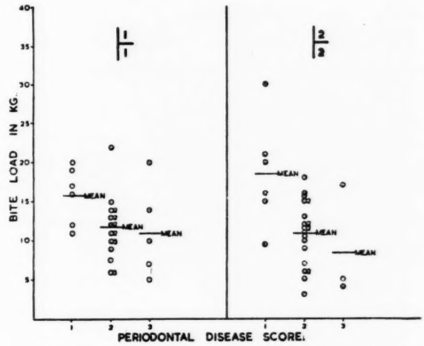

Fig. 5.—Bite loads on incisors of different periodontal disease scores. Note how the mean bite load value drops as the amount of periodontal disease increases, but when visible mobility is present (P.D.S. 3) the drop in bite load is reduced.

2. There were indications that periodontal disease score and bite force were inversely related, but when visible mobility of the teeth was present (P.D.S. of 3) in some cases the bite force seemed to rise. This possibly indicated a decrease in sensitivity of the teeth.

Table IV.

	Number of Measurements	*Average Bite Load*	*Approximate Percentage of Natural Tooth Load*
		kg.	
Natural teeth	215	21·7	100
Tooth-borne dentures	16	11·2	50
Tissue-borne dentures	28	7·4	33

3. *Table IV* summarizes the measurements of bite force on natural teeth, tooth-borne dentures, and tissue-borne dentures.

It may be seen:—

a. The mean of 215 measurements of biting loads on natural teeth was 21·7 kg.

b. The mean of 16 measurements of biting loads on short bounded tooth-borne saddles was 11·2 kg. This figure was much lower than one would expect. Inefficiency of conventional occlusal rests in directing the stress down the long axis of the teeth may be one of the

reasons for this. One of us (M. G.) is carrying out further work on this aspect of denture design. (Geddes, 1958.)

c. The mean of 28 measurements of biting loads on free-end tissue-borne saddles was 7·4 kg. (MacGregor, 1958.)

These figures in *Table IV* show the relative inefficiency of our dentures to support vertical loads when compared to natural teeth and also the advantage of tooth support over tissue support.

4. We could not prove a relationship between the vertical load on tissue-borne saddles and the support area of these saddles, but this may be due to difficulty in controlling the following factors:—

a. The type and health of the teeth opposing the saddle under investigation.

b. The uniform distribution of force over the opposing teeth.

c. The design and fit of the saddles.

d. The length of time during which the denture has been worn.

5. It can be calculated from *Table V* that the mean periodontal area which supports a 1-kg. load is 12·8 sq. mm. and it can be seen that there is a surprising constancy in the ratio of the bite loads on individual pairs of opposing teeth to the periodontal areas of the smallest tooth of each pair, the range being only 5 sq. mm.

Table V.

Opposing Teeth	Bite Force in Kg.		Average Periodontal Area		Area of Periodontium supporting 1 Kg. sq. mm.
	Range	*Average*	sq. mm.	*Tooth*	
$\frac{1}{1}$	5–22	12·9	162·2	$\overline{1}|$	12·6
$\frac{2}{2}$	3–30	12·7	174·8	$\overline{2}|$	13·8
$\frac{3}{3}$	6–39·5	17·8	266·5	$\underline{3}|$	12·7
$\frac{4}{45}$	10–49·5	21·5	219·7	$\underline{4}|$	10·2
$\frac{6}{6}$	14–64	36·7	450·3	$\overline{6}|$	12·2
$\frac{7}{7}$	10·5–58·5	25·7	399·7	$\overline{7}|$	15·5

SUPPORT

At this point it is appropriate to consider the structures which support partial dentures. When a natural tooth is lost the total area of its periodontium is also lost and the remaining area of mucosa which is left to support the load on an artificial replacement is less than that of the periodontal area of the lost tooth. We therefore have a deficit in the support of all partial dentures.

An indication of the size of this deficit is given by the ratio of the periodontal area of the extracted tooth or teeth to the support area of the residual mucosa in the gap (*Fig.* 6).

For example, a lower canine has a periodontal/mucosal ratio (P/M ratio) of 4·8. This means that the area of the periodontium of the canine is 4·8 times that of the mucosal support area in the gap after the extraction of the tooth.

However, the support deficit can be more usefully defined in one of two ways:—

1. In terms of sq. mm., by subtracting the mucosal support area in the gap from the periodontal area of the extracted tooth or teeth. This we call the "support area deficit".

2. By expressing the "support area deficit" as a percentage of the periodontal area of the extracted tooth or teeth. The true support deficit cannot be exactly defined since an axial load on a tooth produces a tensile load on its periodontium (except the apical fibres) while a load applied in the same direction on a tissue-borne saddle produces compression of the mucosa. We might assume that the compressive load is more harmful than the tensile one, and therefore the actual deficit is greater than our figures indicate. On the other hand, we have made no allowance for the area of apical periodontium under compression and have calculated the periodontal support on the basis of the total area of the periodontium.

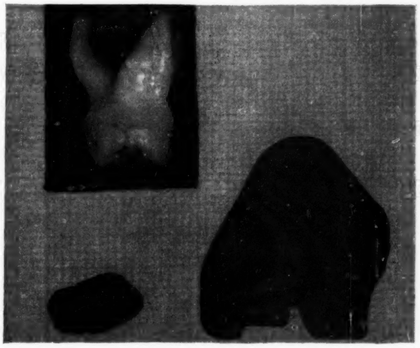

Fig. 6.—Periodontal/mucosal ratio of an upper molar. The shaded areas represent the periodontal area (*right*) and the support area of mucosa in the gap (*left*).

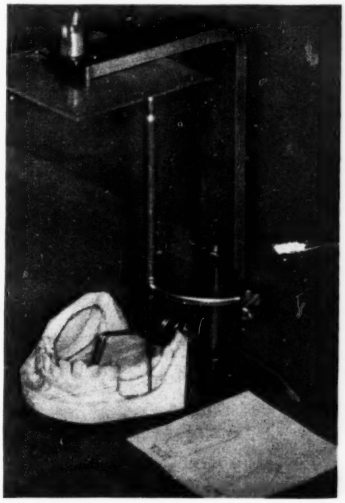

Fig. 7.—Instrument for tracing "vertical support areas" of saddles. The analysing rod is run round the periphery of the saddle area on the model or denture. A spring-loaded pencil, bearing on the underside of the horizontal plate at the top of the instrument, traces a projection of the saddle area. This projection, on the horizontal plane, we call the vertical support area.

Table VI.

Periodontal Areas of Upper Teeth
(From measurements of 5 teeth of each type)

	Range (sq. mm.)	*Average of Five Teeth*
Central incisor	182·8–227·8	204·5
Lateral incisor	134·0–214·2	177·3
Canine	252·0–287·4	266·5
First bicuspid	193·2–251·8	219·7
Second bicuspid	180·8–257·1	216·7
First molar	427·8–530·6	454·8
Second molar	353·5–473·8	416·9
Third molar	285·6–331·7	305·3

Periodontal Areas of Lower Teeth
(From measurements of 5 teeth of each type)

	Range (sq. mm.)	*Average of Five Teeth*
Central incisor	150·8–169·5	162·2
Lateral incisor	155·0–190·2	174·8
Canine	230·4–324·4	272·2
First bicuspid	177·6–216·8	196·9
Second bicuspid	180·2–242·8	204·3
First molar	371·1–491·6	450·3
Second molar	341·3–446·7	399·7
Third molar	272·6–398·5	372·9

We have limited our investigations to the P/M ratios and support area deficits in respect to vertical loads. It is obvious that the value of these factors will vary as the direction of the applied load changes. For example a lateral load applied at right angles to the axis of a tooth would tense rather less than half the periodontal fibres and compress rather less than half, shearing or torsional force being exerted on the remaining fibres.

Periodontal Areas.—One of us (J. L. B.) measured the periodontal areas of 5 teeth of each type, 80 teeth in all. The range and means of these measurements are shown in *Table VI*.

Lower Mucosal Support Areas.—One of us (A. R. M.) measured saddle areas of the lower jaw by means of a modified surveying instrument which was used on dentures as well as on models (*Fig.* 7).

This instrument traced a projection of the saddle area on the horizontal plane and this projection gave us the "support area" available for a vertical load on the saddle.

4. Canine, first molar, and incisor saddles show slightly larger deficits. This is usually due to the undercuts in the abutment teeth preventing the utilization of the whole of the mucosal support area, and possibly also to a slight drifting of the abutment teeth.

5. It is interesting to note that the periodontal area of a lower premolar is about half that of a molar, and this point should be taken into account when placing the rests for lower tooth-borne saddles. This was pointed out by Chick (1953).

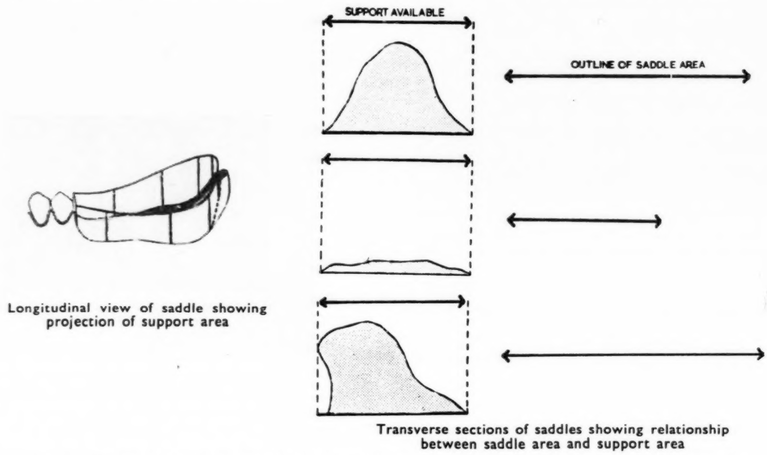

Fig. 8.—Diagram to illustrate the relationship between the "vertical support area" and the saddle area in different types of ridge.

Fig. 8 shows the relationship between the "vertical support area" and the saddle area. The vertical support areas, P/M ratios, and support area deficits of individual lower teeth are shown in *Table VII*.

We can see from *Table VII* that:—

1. There is a large support deficit when teeth are extracted—almost three-quarters of the support area is lost.

2. Since the support area deficit is the area of periodontium of the extracted tooth or teeth minus the vertical support area of residual mucosa in the gap, the number of teeth extracted makes little difference to the size of the deficit when it is expressed as a percentage of the periodontal area.

3. Free-end lower saddles as a rule show a slightly smaller support area deficit because of the greater extension of the saddles towards the posterior.

Upper Mucosal Support Areas.—In assessing the mucosal support area of upper saddles one of us (A. C.) found that many technical difficulties had to be solved before measurement was possible. Two techniques were used; both involved making clear base-plates for the cases investigated. Some were made of polythene, which is flexible, and some of clear acrylic. Some had retainers and some had not, and the results depended very much on the type of base-plate used.

The first group of experiments was carried out by using a fluorescine solution as an indicator between the base-plate and the mucosa. The bite load was then applied to the base-plate which was viewed in cobalt-blue light (*Fig.* 9). The fluorescine showed a clear

line of demarcation between the areas of contact and the areas where contact had been lost. Difficulties were encountered owing to bubbles trapped under the base and the problem of outlining the area accurately with a chinagraph pencil while still under compression. While this technique will prove valuable in the future for assessing the fit of bases it was abandoned for this experiment in favour of another technique. A thin wash of Zelex was put under the base-plate. A vertical load of 4 kg. was then applied to the saddle and kept constant until the Zelex had set. The projections of the areas from which the Zelex had been forced were then measured and it was assumed that they represented the primary vertical support area of the saddle (*Fig.* 11).

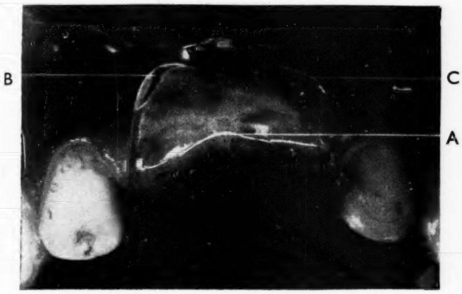

Fig. 9.—Clear acrylic base-plate with fluorescine solution between it and the mucosa, viewed in cobalt-blue light. Note line of demarcation (A) between area of contact on ridge crest and area where contact has been lost under labial flange. Note also small areas of contact at upper outer corners of labial flange (B and C).

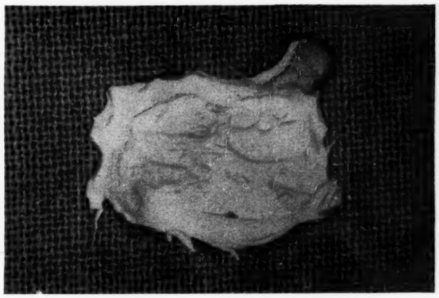

Fig. 10.—Zelex wash under partial upper denture with 2| gum fitted. Note the small primary mucosal support area near the tooth, denuded of Zelex by the force of the bite.

The results of these experiments may be summarized as on page 10.

Table VII.

MANDIBULAR SUPPORT AREA DEFICIT

Mandibular Tooth or Gap	Periodontal Area		Mucosal Support Area		P/M Ratio	Support Area Deficit	Support Area Deficit expressed as Percentage of Periodontal Area
	Range	*Average*	*Range*	*Average*			
	sq. mm.	sq. mm.	sq. mm.	sq. mm.		sq. mm.	
Central incisor	150·8–169·5	162·2	26–46	37	4·4	125·2	77·2
Lateral incisor	155·0–190·2	174·8	33–55	42·5	4·1	132·3	75·7
Canine	230·4–324·4	272·2	47–68	57	4·8	215·2	79·1
1st bicuspid	177·6–216·8	196·9	41–67	55	3·6	141·9	72·1
2nd bicuspid	180·2–242·8	204·3	49–79	66	3·1	138·3	67·7
1st molar	341·3–446·7	399·7	78–131	97	4·1	302·7	75·7
3rd molar	272·6–398·5	327·9	101–146	120	2·7	207·9	63·4
COMBINED SADDLES							
21|	305·8–359·7	337·0	64–73	68	5·0	269	79·8
21|12	611·6–719·4	674·0	157–239	200	3·4	474	70·3
54|	357·8–459·6	401·2	87–114	95	4·2	306·2	76·3
876|	985·0–1336·8	1177·9	273–377	328	3·6	849·9	72·2
87654|	1342·8–1796·4	1579·1	415–507	455	3·5	1124·1	71·2

1. Where no retainers were used displacement of the base occurred in almost every case, and the area which was free from Zelex varied considerably, depending on the type of displacement that occurred. It was found, however, that the support areas were relatively small, especially in cases where anterior teeth had been gum-fitted (*Fig.* 10).

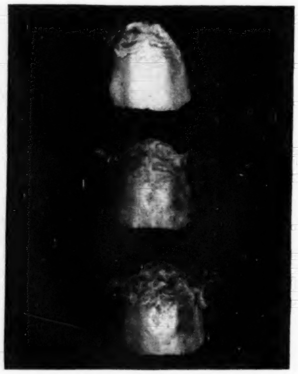

Fig. 11.—Primary vertical support areas recorded by Zelex wash technique under a 4-kg. load. The base-plate at the bottom is made of flexible polythene, the others of acrylic. It can be seen that the presence of clasps increases the size of the support area and that the flexible polythene base has a larger vertical support area than either of the acrylic bases.

2. The presence of clasps on the denture tended to enlarge the support area with both rigid and flexible bases (*Fig.* 11).

3. The use of a flexible base altered the distribution of the support area and in some cases increased it (*Fig.* 12). This finding must, however, be interpreted with caution since the distortion of the base may produce mucosal or periodontal trauma and the areas which were free from Zelex may not necessarily have been true primary supporting areas.

4. As things stand at the moment we have insufficient data to make any positive statement as to whether or not a flexible base increases the support area to vertical load, but we can say that the presence of efficient direct retainers does have the general effect of increasing the support area of tissue-borne dentures.

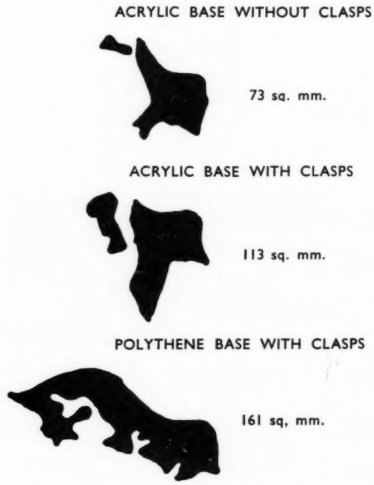

Fig. 12.—Tracing of vertical support areas of 5| saddle. The areas were recorded by the Zelex wash technique, a vertical load of 4 kg. being applied to the base-plates over the saddles.

Table VIII.—Mucosal Support Areas of Upper First Premolar Saddle

Type of Base	Load	Mucosal Support Area Upper First Premolar	P/M Ratio	Support Area Deficit
	kg.	sq. mm.		per cent
Acrylic without clasps	4	73	3·0	60·7
Acrylic with clasps	4	113	1·9	48·5
Polythene with clasps	4	161	1·4	26·7

P/M ratio of lower first premolar 3·6
Support deficit of lower first premolar 72·1 per cent

Table VIII summarizes the findings on mucosal support areas of an upper first premolar tissue-borne saddle.

It can be seen that the type of base and the type of retention influences the size of the support area and also the P/M ratio. It is interesting to note that the P/M ratio and support deficit of the upper first premolar is considerably less than that of the lower first premolar especially when direct retainers are used on the upper base-plate.

TYPES OF SUPPORT

Having defined the support deficit and the loads we may now consider how the load may best be transferred to tissues which are capable of sustaining it.

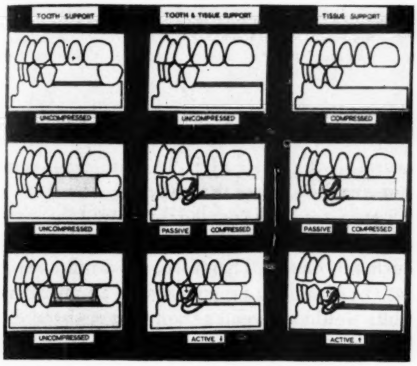

Fig. 13.—Diagrams to illustrate the influence of different impression and bite techniques on the type of support. (*Top row*) Indicates the type of impression (i.e., mucosa compressed or uncompressed) appropriate to each type of support. (*Middle row*) Shows the casts articulated after the appropriate type of bite (compressed or uncompressed) has been taken, and shows the stress breakers in their passive state on the articulator. (*Bottom row*) Shows the dentures in the mouth and indicates the action of the stress breakers.

There are three possible methods of support for partial dentures:—

1. Entirely tooth-borne;
2. Entirely tissue-borne;
3. Partly tooth-borne and partly tissue-borne.

Every denture will fall into one of these three classes.

Theoretically the type of support employed depends as much on the prosthetic technique as it does on the actual design of the denture. *Fig.* 13 illustrates how different prosthetic techniques result in different types of support being utilized for each of three dentures.

Tooth-borne Denture.—

1. The impression is taken with a soft material so that the mucosa is not compressed.

2. Wax bite-blocks are used for the registration of centric occlusion and care is taken to avoid compression of the mucosa at this stage.

3. When the denture is fitted the whole of the clenched and masticatory loads will be transferred to the abutment teeth by the occlusal rests and the mucosa underlying the saddles will not be compressed or loaded.

Tissue-borne Denture.—

1. The impression is taken in impression compound in such a way that the mucosa of the saddle areas will be compressed.

Fig. 14.—Radiograph of 32|. Note the loss of bone distal to 3| caused by the extraction of 4|.

2. The bite-block is made of impression compound and, when centric occlusion is registered, the bite-block and opposing teeth contact first and further closure brings the natural teeth into contact as the mucosa under the saddle is compressed. When the bite-block is placed on the model, which has been cast from the compression impression, it will be found that the opposing teeth of the models are in contact.

3. A stress-breaker between the clasp and the finished denture base simply allows decompression of the tissues when the denture is not under load, and is active occlusally in this state, but returns to its passive condition when the load is applied and therefore does not transfer any load to the teeth.

Tooth- and Tissue-borne Denture.—

1. The impression is taken without compressing the mucosa.

2. The bite is registered with an impression compound block which compresses the mucosa. When the models are articulated it will be found that the standing teeth are propped apart by the amount of the compressibility of the mucosa.

3. A stress-breaker between the clasp and the finished denture base is then passive when the denture is inserted, but becomes active gingivally when the biting load is applied and transfers that load to the teeth.

So much then for the theoretical distribution of the load. We shall now examine the practical aspects of tooth support and of mucosal support.

Tooth Support.—Obviously tooth-borne saddles will accept both clenched and masticatory loads. The question then arises as to how these loads can best be distributed to the remaining teeth. One of us (M. G.) has taken measurements from radiographs of teeth adjacent to a gap in the dental arch (*Fig.* 14). The measurements were made from the amelocemental junction to the crest of the residual alveolar ridge, and from the amelocemental junction to the top of the interdental table between the abutment tooth and its neighbour. The mean difference between these two measurements is shown in *Table IX*.

This indicates that there is a considerable loss of bone on the side of the abutment tooth nearest the gap, with a corresponding loss of the periodontal membrane. This means that the teeth adjacent to the gap are perhaps the least suitable teeth in the remaining dental arch to accept the loads applied to tooth-borne dentures. A recent review by one of us (M. G.) of 61 chrome-cobalt partial dentures showed that fremitus or mobility was present in many of the teeth, carrying occlusal rests, which were adjacent to saddles. It would, therefore, seem wise, whenever possible, to place occlusal rests for tooth-borne dentures on teeth within the intact portions of the dental arch. This arrangement has the additional advantage, as pointed out by Chick (1953), when applied to premolars but not molars, of relatively decreasing the load on the premolar by increasing the distance from the point of application of the load to the rest and, as we have already shown, the periodontium of a premolar has approximately half the area of that of a molar.

Another interesting point in connexion with tooth-borne saddles is that the average load on

Table IX.

Number of Cases	*Loss of Bone at Alveolar Ridge Crest**	
	Range mm.	Average mm.
29 (P.D.S. not recorded)	1–4·1	3·4
7 (P.D.S.: 0)	1–4	2·7

* Loss of bone is calculated by measurement of radiographs. The measurement from amelocemental junction of the abutment tooth to interdental table between abutment and adjacent tooth is subtracted from a similar measurement on the side of the abutment tooth next to the gap.

these saddles, measured by the bite-force gauge, was less than the average load on natural teeth (*Table IV*). This finding is somewhat puzzling, since theoretically a load of this sort on a tooth-borne saddle should be distributed over the whole periodontium of both abutment teeth. Therefore, we would expect that the biting load registered on a tooth-borne saddle would be greater than that registered by either of the abutment teeth. The most likely reasons for the reduced biting load on tooth-borne saddles are:—

1. The rests do not transmit the load down the long axes of the teeth.

2. The relatively small areas of conventional rests exert crushing and shearing forces on enamel and dentine to which the patient is sensitive. The crushing strength of dentine is approximately 13 kg. per sq. mm., and the surface areas of conventional occlusal rests vary from about 2 sq. mm. to 7 sq. mm. with a mean of 4·5 sq. mm., so that it is quite possible that loads approaching the crushing strength of dentine can be exerted through the rests, especially if they are not well fitting and contact at only a few points. The hardness of the metal rests exaggerates this effect. We found that using the bite-force gauge with unpadded metal ends invariably resulted in a lower bite force being registered than when the ends of the gauge were padded.

We have, therefore, two tentative conclusions to draw about the occlusal rests on tooth-borne dentures.

1. The rests should fit accurately and cover a sufficiently large area of tooth substance.

2. They should be placed on teeth within the intact portions of the dental arch.

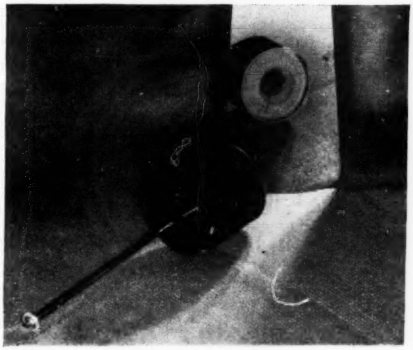

Fig. 15.—Mucosal compressibility gauge. The clear Perspex disk on the end of the instrument is held in light contact with the surface of the mucosa while the spring-loaded plunger passing through the disk compresses 1 sq. mm. of mucosa. The degree of compression is registered in fractions of a mm. on the dial.

Tissue Support.—In any discussion of tissue support there are two questions to which we must find answers:—

The first is: Should we expect tissue-borne dentures to accept part of the clenched load or only the masticatory load?

When we consider the support deficit it would seem wise to limit the load on tissue-borne dentures to the masticatory load, especially in cases where there are sufficient natural teeth to accept the clenched load without periodontal trauma. On the other hand, when there are only a few remaining teeth it is clear that periodontal trauma will occur unless the denture accepts part of the clenched load. In order to do this it must "prop the bite" by the same amount as the compressibility of the mucosa (*see Fig.* 13), since mucosa cannot accept load without being compressed. We have designed a simple instrument (*Fig.* 15) which measures the compressibility of mucosa at different points. A plunger exerts a load of 100 g. over an area of 1 sq. mm. of mucosa. The dial on the gauge measures the compressibility of the mucosa in terms of fractions of a millimetre. It is of course obvious that these readings will give us only an approximation of the compression which is likely to be obtained by a compression impression or a compression bite technique. In order to make more

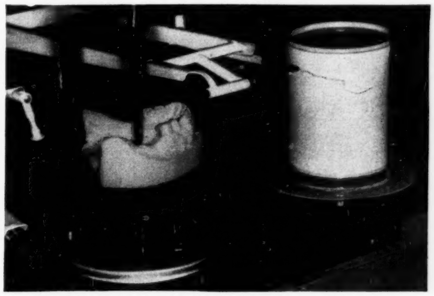

Fig. 16.—Cast-tracing instrument. The cast is mounted by means of a jig on the turntable which is synchronized with the recording drum. The counter-balanced arm between the turntable and the drum carries a guide rod which rests on the cast and a pen which traces the profile of the cast on the drum. A second arm for tracing horizontal sections of the cast can be seen at the extreme left of the photograph.

accurate measurements of the total compression of mucosa we took tracings of casts from Zelex impressions and from compression impressions with the instrument shown in *Fig.* 16. We found that the readings from a typical trace with this instrument were not identical to the readings of the tissue-compressibility gauge but they were approximately proportional to them. With these two instruments it is therefore possible to get an indication of how much the bite would have to be propped by the denture in order that the mucosa would accept a specified clenched load. This leads us to the second question: How long will such a denture support this clenched load before sinking down to the level at which it supports only the masticatory load?

Our method of investigating this problem was as follows:—

1. We selected a patient with bilateral lower free-end saddles.

2. Using the instrument shown in *Fig.* 16 we took a tracing of a cast from a Zelex impression which did not compress the mucosa.

3. We then superimposed a tracing of a cast from a compression impression of the same mouth (*Fig.* 17 A).

4. We fitted a tissue-borne denture which accepted the clenched load. This was worn for one week.

5. At the end of this period a Zelex impression was taken and the tracing from this cast

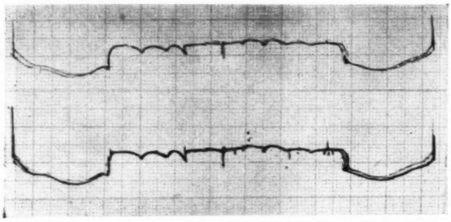

Fig. 17.—A, Superimposed profile traces of a cast from a Zelex impression and a cast from a compression impression. The spaces between the terminal portions of the trace indicate the amount of mucosal compression of the free-end saddles. B, The dark line which has been superimposed on the traces in (A) is the tracing of a cast from a Zelex impression after a denture had been worn for one week. It can be seen that this line more or less coincides with the compressed position of the mucosa, indicating "sinkage" of the denture.

was superimposed on the two previous tracings (*Fig.* 17 B).

6. This third tracing showed that the mucosal level now coincided with that of the compressed mucosa on the second trace. This indicated that the denture had sunk to the line of the compression impression.

Unfortunately this work was started only recently and these are the only tracings we have of this phenomenon. On the strength of this single case we might tentatively suggest that clenched load cannot be supported by mucosa for more than a week.

CONCLUSIONS

1. Masticatory loads and clenched loads are defined and it is shown that the masticatory load on natural teeth is about half that of the average clenched load, and that the masticatory load on a premolar tooth in a full denture is only about 1 kg. compared to the average clenched load of 21·7 kg. on natural teeth.

2. When a tooth is extracted approximately three-quarters of the support potential is lost, i.e., a 75 per cent support deficit appears. This is compensated to a certain extent by a reduction of load exerted by the patient on the artificial replacement.

3. The mean clenched load on tooth-borne dentures was found to be approximately half that on natural teeth. This theoretically indicates faults in design of these dentures.

4. The mean clenched load on tissue-borne dentures was found to be approximately one-third of that on natural teeth.

5. The size of the mucosal support area in maxillary tissue-borne dentures of identical outline form was found to vary with the presence of retainers and the flexibility of the base. It is probable that a similar investigation of mandibular dentures will produce the same findings. If this is so it would explain our inability to find a relationship between the vertical load and the support area of mandibular saddles.

6. Bite loads and periodontal scores should be taken of all partially edentulous patients to assess the support available before dentures are designed.

7. Short bounded saddles should, as a general rule, be tooth-borne.

8. It is desirable, in some cases, but may not be possible, to make tissue-borne dentures accept the clenched load. If, however, there are sufficient natural teeth present to support the clenched load without damage, tissue-borne dentures should accept only the masticatory load.

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"OPERATORS FOR THE TEETH" AND SURGEON DENTISTS

A BRIEF SKETCH OF DENTISTRY MORE THAN A CENTURY AND A HALF AGO

By G. WARD

THE *Evening Standard* published on February 25, 1958, the following report:—

"Tooth-pulling is now barred by regulations governing the busy, open-air market in Beresford Square, Woolwich, opposite the main gates of the Royal Arsenal. It is at least fifty years since a tooth was pulled in the Square, but at one time dentists often set up their stalls alongside the other barrows. Often the extractions—not guaranteed painless—were given free to attract a crowd, to whom the dentist would sell 'cure-all' medicine. One of the most famous tooth-pullers was called 'The Sequah'. In the 1880's, dressed as a Red Indian, he used to roll into the square about six times a year in a brightly-painted horse-drawn caravan. He employed a small brass band, which was stationed on the roof of the caravan. When a victim was having his tooth drawn the band played loudly to drown the screams."

Mountebanks and tooth-pullers no longer compete with the dental surgeon, but in these days of efficient legislation and compulsory qualifications it is easy to forget that only a few short decades separate "The Sequah" and his colleagues. The illustration (*Fig.* 1) gives a glimpse of the early days of dentistry, about 100 years before "The Sequah" "practised" in Woolwich Market. It shows a model, constructed by the author, of the interior of a late-eighteenth–early-nineteenth century dental surgery. This was a period of transition Barbers were permitted to extract teeth and the qualifications for practising as a dentist were so slight that ivory turning was considered a business "naturally embracing that of dentist". At the same time, men such as Pierre Fauchard, at an earlier date, John Hunter (although not actually a dentist), Thomas Berdmore, William Rae, Joseph Fox, and others were endeavouring to raise dentistry from little more than a trade to the status of a profession.

The operating-chair shown is an ordinary arm-chair with a high back. Chairs capable of being raised and lowered and with movable head- and foot-rests, the forerunners of the modern dental chair, did not appear until the latter half of the nineteenth century. A porcelain bowl on the table beside the chair was the precursor of the present-day spittoon.

The wall cabinet on the left of the fireplace contains the dentist's instruments. The forceps and key were used for extraction, the latter being extensively employed on the posterior teeth. In these days of efficient anæsthetics, it is difficult to imagine the agony attendant on dental operations before the "new era in tooth-pulling", opened up by Horace Wells's discovery of nitrous oxide as an anæsthetic in 1844.

Before the advent of foot-operated dental engines about 1870, files, scrapers, and hand-drills were used to excavate carious teeth which might then be filled with non-cohesive gold foil or mastic or metallic "cements". The former was a mixture of lime and iron oxide with morphine and the latter an alloy of low-fusing metals which was either melted and poured into the cavity or placed cold in the cavity and made plastic with a hot instrument.

The dentist is wearing the usual operating dress of the time: an old and dirty coat, the tails of which were probably utilized for cleaning instruments.

Incredible as it may now seem, cleanliness and the sterilization of instruments were then regarded as an unnecessary fuss. At that time, very few houses had a proper water-supply and water might be brought from a pump for the wash-stand shown beneath the window, although the dentist would probably seldom wash his hands unless they felt uncomfortable.

On the table beside the chair is a set of dentures carved from ivory. Apart from gold and platinum, ivory and bone were the only materials available as a basis for dental restorations. Teeth were carved from the material of the base or human teeth or the early porcelain teeth might be fastened to the base by rivets.

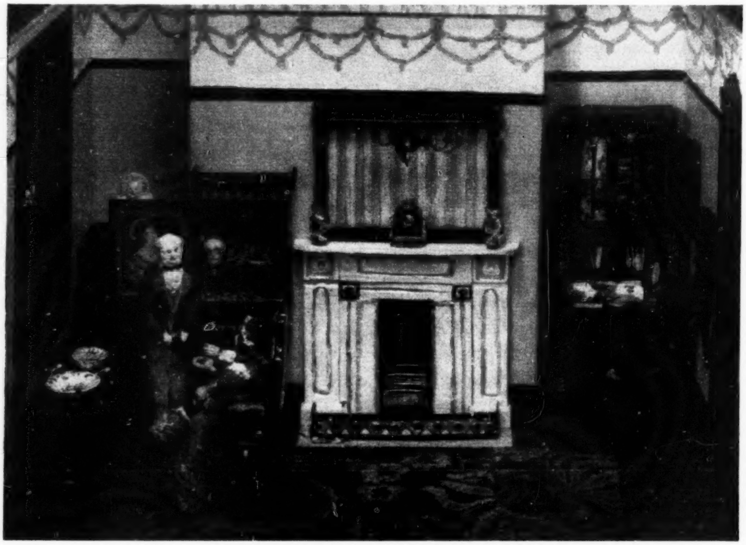

Fig. 1.—Photograph of the model of a dental surgeon (*circa* 1800) in his surgery.

Wax was the chief impression material, and what now seems the relatively simple procedure of obtaining a plaster model from an impression was not described until 1756. At first, dental appliances were undertaken by silversmiths and jewellers, but eventually, by the mid-nineteenth century, the entire processes were carried out in the dentist's own workroom.

Owing to the inefficiency of these early dentures, transplantation was widely practised and it was common for people of the poorer classes to sell their teeth to dentists for this purpose.

The model described in this article is in the collection of the Wellcome Historical Medical Museum, Euston Road, London.

ORAL SURGICAL DIAGNOSTIC AND TREATMENT PROBLEMS OF INTEREST TO THE GENERAL PRACTITIONER*

By **J. LORENZ JONES,** D.D.S., F.A.C.D., *Beverly Hills*

IN 1953 the American Dental Association at the annual session at Cleveland, Ohio, gave its approval to the following definition of oral surgery: "The specialty of Oral Surgery is that part of dental practice which deals with the diagnosis, the surgical and adjunctive treatment of the diseases, injuries and defects of the human jaws and associated structures."

The foundations of oral surgery are to be found in many and varied historical references. However, it was not until Fauchard's book *Traitê de Chirurgie Dentaire* in 1728 that oral surgery became a problem peculiar to the dental profession. Recently, some branches of medicine have apparently looked with covetous eyes toward the field of oral surgery, at least in the United States. This may well be due to the great work of Sir Alexander Fleming and others during the past two decades which has enabled many general practitioners of medicine to render care to their patients which formerly was the sole province of the specialist.

I lack the knowledge to give an historical background of oral surgery on the Continent, but would like to comment that the term was first used by James E. Garretson (1828–95) and he entrenched it in the American dental curricula when in 1864 he introduced it as a major subject in the curriculum of the Philadelphia Dental College, now School of Dentistry, Temple University. Others including Fillibrown, Brophy, Cryer, Gilmer, Brown, and Ivy, followed rapidly, and their contributions are well known to all. This has culminated in the development of the American Board of Oral Surgery (1946) and the development of residencies and internships in the specialty throughout the United States. As of 1946, there were 430 hospitals reporting dental departments with 161 internships and 100 residencies in the U.S.A. The period of training is three years for oral surgery, one of the requirements set by the Board.

Adequate equipment and the knowledge to use it is implied in any surgical procedure. For the general practitioner interested in oral surgery, I would recommend a good source of light, preferably a headlight, a suction with interchangeable small tips, suitable retractor for use in retracting cheeks and flaps, cutting instruments which should be sharp at all times, including scalpel, chisels, scissors, and bone burs. Forceps need not be numerous or complex, and those suitable to the operator and requirements are the best. A few elevators and a knowledge of their proper use should complete the armamentarium which may be kept on a tray, sterile, and ready to assist the operator in any routine procedure. If available, a well trained assistant can relieve the operator of the premature acquisition of grey hair and ulcers, to say nothing of conserving his time.

In the discussion of procedures I wish to keep my remarks as simple as possible, but cannot over-emphasize the need to avoid trauma in any procedure in the oral cavity. A carefully reflected mucoperiosteal flap will heal quickly; an area of mucoperiosteum bruised and abused in any extraction will result in undue pain, swelling, osteitis, and possible infection, to say nothing of the acquisition of a dissatisfied patient. In addition, this traumatized mucoperiosteum must recover from the insult before adequate healing of tissue and bone can result. Remember, your periosteum is also a source of nutrition for bone, regardless of its anatomical location.

In any extraction wherein you might expect trouble, it is a good rule to resect the interdental papilla mesial and distal to the site of the extraction, permitting careful reflection

* A paper delivered to the American Dental Society of Europe, August 28, 1957.

of at least the alveolar crest fibres of the peridontal structure. Then, should a tooth be fractured in removal, the flap may be reflected adequately. This may be done by reflecting the buccal mucoperiosteum at least one tooth mesial and distal to the operative site. A vertical flap does not have to be made as a general rule, and upon completion of the procedure, two simple interrupted sutures at the mesial and distal of the alveolus will usually suffice to maintain the tissue flap in its proper relationship to the underlying bone. Care lavished on soft tissue will be repaid many times over in rapidity of healing.

Where a flap has to be extended mesial or distal to a tooth into an edentulous area, then carry the incision along the alveolar crest as much as possible. Closure is simple, and no scarring will result. A vertical flap will result in some scarification. This simple procedure will enable the soft tissues to bear the stresses of a denture.

The removal of multiple-rooted teeth may be the source of considerable trouble. There are a few fundamentals, which, if observed, may make the procedure easier for both operator and patient.

In the removal of a multiple-rooted tooth in the maxilla, particularly where the maxillary sinus may be involved, an adequate flap should be laid. Then enough bone is removed on the buccal aspect to expose the buccal root bifurcation. With the flap retracted, the buccal roots are sectioned transversely with a chisel or bur. If performed with care, the crown and palatal root can usually be removed by a buccal "rolling" of the forceps. The buccal roots may be divided by a twist with an elevator, and then removed. Bone and soft tissue is thus preserved, and a good base is made available for any future prosthesis.

In the removal of lower molar teeth when there are divergent roots, hypercementosed roots, or extremely dense cortical bone, it is always advisable to reflect a flap in the buccal direction. The interproximal free gingival tissues should be resected at least one tooth mesial and distal to the operative site. The flap may be mobilized readily and then reflected buccally, exposing the field. If necessary, bone may be removed to the bifurcation, and the crown removed. This may be done by forceps and chisel, or by burs. With the roots separated, the operator can remove the cancellous bone between the roots and usually this may be done by the careful application of elevators. Should this fail, then it is advisable to remove the roots by sectioning with fine chisels and the apices with root picks.

I should like at this point to re-emphasize the cardinal point of adequate exposure of the operative site. As my teacher in surgery once put it to me, "If you can't see it, you can't do it". This implies not only a good open field, but a suitable and efficient aspirator with varied tip-sizes, brilliant illumination, and a capable assistant who can manipulate the suction, aid in retraction if necessary, and pass instruments as needed.

The removal of impactions can represent more of a challenge to the operator than a fractured mandible. Careless removal often complicates the procedure by unnecessary trauma, post-operative pain and infection, and sometimes, a fracture of the mandible as well. The same basic principles of exposure of the operative field apply here. With the greatest diameter of the crown exposed, it is possible to section the tooth itself, removing the roots separately. Bone is conserved, and freedom from trauma ensures good healing, to say nothing of the gratitude of the patient. The use of adequate pre-medication, good anæsthesia, whether it be local or general, is advisable. The operator should never feel that he must hurry. A little time saves time.

Previously I alluded to a fracture of the mandible which I am sure many of you have been called upon to treat. Surgical judgement is paramount and the evaluation of the patient with the assistance of the physician is usually indicated. I do not feel that any dentist should try to assume the total health care, but should assume and direct the total oral-health care of the patient. With the assumption that a patient has been properly evaluated, and you are confronted with a treatment problem for a fractured mandible or maxilla, remember that the occlusion is the most efficient splint

available to you. In the event that this is inadequate, then in the mandible I suggest open reduction and supplementary inter-dental wiring. In edentulous cases, circumferential wiring may sometimes be indicated. However, in my opinion, the pain and œdema are seldom worth while, and a good open reduction with later construction of a new prosthesis is the preferred method. The use of external pin fixation may be considered, but in my opinion is not the panacea it was once thought to be. The simplest and most direct reduction possible is the method of choice. I do not wish to imply that external pin fixation is inadequate, as I use it in selected cases. It can be used in both the maxilla and mandible, particularly in the former for external support fixation, but this application must be very carefully adjudicated.

We have so far only discussed some of the elements of the traumatic phase of oral surgery, perhaps because this is the first thing one associates with this portion of dental practice. However, there is an important field of diagnosis of soft tissue and bone lesions which anyone practising oral surgery should be capable of handling. In addition to diagnosis a knowledge of radiography and pathology above that of the average general practitioner is necessary, and on this knowledge treatment is planned.

If in the diagnosis or treatment of any oral lesion there exists any doubt in your mind as to the lesion, I suggest that you consult a fellow practitioner. The mention of the need for biopsy may sound redundant, but any lesion of the soft tissue which is removed should be examined, and the specimen should include some to the adjacent tissues. Any abnormality of bone as to size, shape, or quality should be adequate indication for biopsy.

In the management of your patients, you will frequently prescribe medications. It is hoped that this will be on the basis of therapy, and not empirically. Recently, I read a report (Kerlan, 1957) of the United States Drug Administration which mentioned: "it is to be noted that 50–90 per cent of the drugs prescribed by physicians and dentists used in hospitals to-day were unknown 15 years ago, and many of these, although extremely potent, are capable of great harm". This is no under-statement, and one must be aware, through an adequate history, of allergies which may be present, and possible reactions to drugs which may be employed. The practitioner must keep abreast of his current literature, particularly in the field of therapeutics and pharmacodynamics. The use of drugs which may cause severe allergic reactions should remind one that it is advisable to have emergency drugs and means for their administration present at all times. I believe that every dentist should have an emergency kit available for use, included in which should be a readily available supply of oxygen, ready for administration. A good reference work to have at hand, however, and one which I recommend, is the American Dental Association's *Accepted Dental Remedies.*

We have the responsibility of early detection of malignancies and should always be aware of the possibility of such being present. If one has the knowledge and ability to treat them, all well and good, but I know of very few oral surgeons in the U.S.A. who have. Rather, the diagnosis of a lesion should lead to the reference of the patient to the best source of treatment. In most of our schools, and in all hospitals, tumour boards have been set up and it is the rightful duty of these groups to determine treatment in such cases. Our duty lies in the ability to give the best care possible to the oral health of the patient.

Some of us may ask about reference books which might be suitable. I have already mentioned the *Accepted Dental Remedies*, and in addition recommend Thoma's *Oral Pathology and Oral Surgery* and Bernier's *The Management of Oral Disease.* These three volumes should enable each of us greatly to enlarge our knowledge in the field of diagnosis, treatment, and planning of oral surgical procedures.

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POST-DAMMING THE FULL METAL PALATE

By **ROY STORER**, F.D.S. R.C.S.

Department of Prosthetics, School of Dental Surgery, University of Liverpool

The retention of a full upper denture is considerably enhanced if a peripheral seal is obtained between the periphery of the denture and the tissues at the mucosal reflection. Because of the elastic quality of these tissues, contact is maintained and seal preserved as a vertically displacing force is brought to bear on the denture.

The circle of seal must be completed by the provision of an accurately positioned post-dam, and one of the major causes of poor retention in the upper denture is the placing of the post-dam in too anterior a position. For the post-dam to be effective it must be placed on soft compressible, non-vibrating tissue just back of the junction of hard and soft palates. The correct position and degree of compression necessary can only be determined by a combined visual and digital examination of the area. So often it is left to the technician to decide by looking at the stone model where the post-dam should lie and to what depth it should be cut. With an acrylic palate errors can be corrected by increasing or reducing the extent and depth, but where a metal base is used this becomes more difficult or, in the case of chrome cobalt, virtually impossible.

A metal base to a denture is frequently advised to enhance retention where the prognosis for this is poor. The obtaining of maximum retention in such cases will be dependent on the correct positioning of the *post-dam*.

The Boos Dental Laboratories (U.S.A.) have for some time advocated an adjustable acrylic post-dam and a similar procedure has been followed successfully by the writer for the past two years in all cases where a full upper metal base has been used.

Fig. 1.—Chrome-cobalt palate with posterior mesh.

Fig. 2.—Completed denture with acrylic post-dam.

TECHNIQUE

After a sodium bicarbonate rinse and prior to the taking of the major impression, the palate is dried with a napkin and examined visually and digitally for the correct post-dam area. With a fine indelible pencil point a line is drawn on the mucosa across the palate from one pterygomaxillary fissure to the other. The impression is then taken and on withdrawal the line will be seen to have been transferred to the impression surface. This is accentuated so that in its turn the line will be transferred to the master model.

The technician now has the post-dam area marked *provisionally* and he proceeds in the construction of the metal base. During the laying down of the wax the posterior quarter-inch of the palate is formed as a mesh-work. The appearance of the cast palate is shown in

Fig. 1. Wax bite-rims are added to the metal base and the posterior mesh-work covered with wax. The case is taken through the normal bite registration to the try-in stage. The final anteroposterior position and vertical depth of the post-dam is now determined and cut on the master model. The denture is processed and the original wax post-dam is now formed in acrylic resin (*Fig.* 2).

ADVANTAGES

By this technique a really accurately positioned post-dam can be obtained and, if necessary, modified by additions or reductions to the acrylic resin.

After a period of time there is a tendency for the posterior seal to become less, due to a permanent stretching of the elastic tissue and a lack of maintenance of intimate contact between the tissue and the post-dam when a displacing force is brought to bear on it. When this situation arises, the acrylic post-dam can quite easily be accentuated, so that the original peripheral seal may be recovered.

SUMMARY

An adjustable post-dam for an upper metal denture is described.

Acknowledgements.—The writer wishes to thank Mr. H. M. Oldfield, Senior Technician, Liverpool Dental Hospital, for his co-operation and Mr. S. Bailie for the illustrations.

THE CONSTRUCTION OF A FACIAL PROSTHESIS INCORPORATING A NEW MEANS OF RETENTION

By S. EDMONDSON

Orthodontic Technician, Bromsgrove General Hospital, and Part-time Lecturer in Dental Technology, College of Technology, Birmingham

THE object of this communication is to present an original method of retention whereby a prosthesis will at all times remain in contact with the surface of the skin, particularly where moving contours of the face are involved. Search of the literature on this subject has failed to reveal mention of the technique to be described. Although this method of retention can be applied to many types of prosthesis, the one upon which it was developed was to replace a destroyed nose. This type of prosthesis, therefore, will be described as an example.

It is well known that an artificial nose can be quite successfully constructed and retained by a spectacle frame incorporating a rigid attachment for the nose. However, unless the patient keeps his face absolutely immobile the seal between the appliance and the skin will be broken. Further, as the patient leans forward the appliance tends to leave the face completely. To overcome this, it was decided to use a hinged attachment incorporating a plain orthodontic finger spring which would maintain a constant but gentle pressure between the appliance and the skin.

The type of the appliance and the peculiarities of the particular patient will demand varying degrees and directions of pressure, but these latter can be controlled at will by the choice of differing wire gauges and siting of the spring anchorage.

MATERIALS AND EQUIPMENT REQUIRED

1. Horn-rimmed spectacle frame.
2. Stainless steel tube—internal diameter 1·0 mm.
3. Stainless steel hard drawn round polished wire.
4. The following thicknesses of wire are recommended for this particular case—1·0 mm., 0·7 mm., and 0·6 mm. diameter.
5. An electric resistance spot welder.

CONSTRUCTION

It is presumed that a well-fitting acrylic resin nose has been fabricated and will henceforth be referred to as the prosthesis.

Using a suitable fissure bur, two holes are drilled, both horizontal and parallel, through the bridge of the spectacles (dotted lines *Fig.* 1),

Fig. 1.—Dotted lines indicate position of two holes drilled horizontal and parallel through the bridge of the spectacles. The half-moon shaped loops are the nose rests of the spectacles.

to accommodate two short lengths of stainless steel tubing, the internal diameter of which is 1·0 mm. For fixation the tubes may be cemented with self-polymerizing acrylic resin or they may be warmed before insertion. The tubes in turn accommodate the two arms of a 4 in. piece of 1·0 mm. hard round wire bent into a square-shaped U and threaded (from the front) through the holes in the spectacles

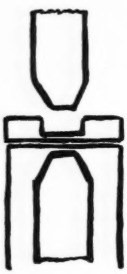

Fig. 2

Fig. 3

Fig. 2.—Hinge tubing recessed to enable the upper electrode to weld the tubing to the U-shaped wire.

Fig. 3.—The ends of the wire, welded to the recessed tubing, recurved to provide retention within the resin prosthesis. Cantilever spring assembled on the centre of the hinge tubing.

to eventually form the centre spindle of the hinge. The use of tubes results in an increase in rigidity of the hinge and also considerably reduces the holes. Thus, stability of the appliance is increased and a more accurate positioning of the prosthesis is facilitated.

The hinge comprises a straight, hollow sleeve of tubing welded to a U-shaped piece of round wire. The process of welding across a piece of hollow tubing is not a reliable procedure. Because of this, the sleeve must be recessed in the centre to allow the electrodes to be positioned for the purpose of spot welding the

A B

Fig. 4.—A, The ends of wire protruding from the inside of the bridge after having been threaded through the holes in the front. B, The end of one piece of wire has been bent (to accommodate the hinge) and the excess removed from both pieces.

U-shaped piece of 0·7 mm. hard wire to the remaining central position (*Fig.* 2). The length of the recessed tube used for the hinge corresponds to the distance between the two pieces of tubing located in the bridge of the spectacle frame.

The ends of the wire welded to the recessed tubing are reduced in length until they are measuring about 15 mm., when they are recurved to provide retention within the resin prosthesis (*Fig.* 3).

A piece of round 1·0 mm. diameter stainless steel wire about 4 in. in length is selected to form the second and solid part of the hinge. Two right-angled bends are inserted in the wire, the distance apart being the same as the tubes located in the bridge of the spectacle frame. The tags of this second U-shaped piece of wire are then inserted into the holes in the bridge and the wire pulled tight (*Fig.* 4 A). Subsequently, only one of the tags of wire is bent at a right angle to meet the others, the excess on both being removed and the ends welded together to retain the hinge in position. The point at which the tag should be bent at a right angle is estimated by assembling the nose on the spectacles along with the tube portion of the hinge. This point should be marked with ink, the bend imparted, and the excess removed (*Fig.* 4 B). Welding is performed after final assembly.

Spring Construction.—The spring is of the simple cantilever type, and is constructed of 0·6 mm. stainless steel wire. The coil, which should be a loose fit on the tubing, is then passed over the sleeve of the hinge which in turn is fitted on the 1·0 mm. wire, forming the spindle of the hinge (*Fig.* 3). The ends of the coil spring should be about 8 mm. and 24 mm. in length. The next step is to attach the sleeve portion of the hinge and the longer arm of the coiled spring to the inside of the prosthesis. This is accomplished by marking the position of the three tags while the components are assembled, afterwards affixing the outer ones with self-polymerizing resin.

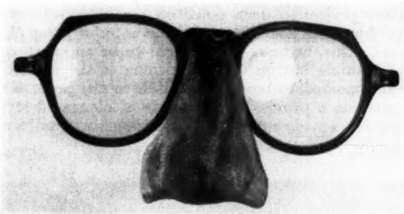

Fig. 5.—Posterior view of the nose showing attachment of coil spring arm by means of wire loops and the hinge tags by means of self-polymerizing acrylic resin.

Fig. 6.—Front view of acrylic resin nose attached to spectacle frame by means of a hinge.

Before final assembly, a small hole is drilled on the centre of the bridge of the spectacles and from the rear to accommodate the tail of the spring.

Final assembly is accomplished by passing one end of the wire shown in *Fig.* 4 B through the hinge tubing and uniting the ends of the wire by welding at the point indicated. The rear and front views of the completed prosthesis are shown in *Figs.* 5 and 6.

The path of action of the spring is towards the patient's face and consequently provides that adjustable pressure so necessary in this type of facial restoration. It follows that the ear-pieces of the spectacles must fit closely without hurting the patient. Fit may be improved by first warming the ends and bending to the required shape.

SUMMARY

By the use of a simple finger spring a facial prosthesis may be constructed which will adapt itself to skin movements. The principle involved and details of construction have been described.

Acknowledgements.—I wish to thank Dr. R. O. Walker, F.D.S., Queen Elizabeth Hospital, Birmingham, for his permission to publish this article. Also Mr. J. W. Dick for providing an acrylic resin artificial nose; Mr. Dee, Clinical Photographer, for the photographs used.

Reduction of Radiation Hazards in Dental Radiography

Fifteen practical ways of reducing radiation hazards are given: (1) Elimination of unnecessary and repetitious exposures; (2) Better commercial protection to tube head; (3) Better technician discipline and safe procedure; (4) Use of a protective lead apron for patients; (5) Strict collimation and restriction of primary X-ray beam; (6) Use of a 16-in. target-skin distance; (7) Use of extra-fast films; (8) Use of 3-mm. aluminum filtration of primary beam; (9) Use of 5-min. film development time; (10) High kilovoltage techniques; (11) High-intensity film illuminators; (12) Adequate room design and protective barriers; (13) Physical calibration of radiation output of equipment; (14) Personal monitoring with dosimeters and film badges; (15) Intensification of roentgen images with screen cassettes.—CAMPBELL, J. A. (1958), *Dent. Dig.*, April, 177.

ELONGATED STYLOID PROCESS CAUSING UNUSUAL SYMPTOMS

By **P. J. STOY,** F.D.S.
Dental Department, The Queen's University of Belfast

THE length of the styloid process may vary but when curved or elongated it may give rise to symptoms that are not readily recognized. One such unusual symptom—that of glossopharyngeal neuralgia—has recently been reported (Battersby, 1958); others have been described as resulting from pressure on either the external or internal carotid arteries and include referred pain in the ophthalmic region or vertex, and tinnitus (Eagle, 1949). A case exhibiting symptoms due to a straight but elongated styloid process is now reported.

Fig. 1.—Radiograph showing elongated styloid process in apparent close relationship to the angle of the mandible. S.P., Styloid process.

Fig. 2.—Photograph of skull with a somewhat less elongated styloid process to show its relationship to the inner side of the mandible. S.P., Styloid process.

CASE REPORT

The patient, a female, aged approximately 50 years, was referred by her medical practitioner complaining of a sensation of something sticking into her throat, which was constantly present, and which she stated had first begun to trouble her about a year previously. At times it felt as though a "water blister" was present on the right side of the throat. She could, however, swallow her meals and had no eructation of food or fluids.

During the previous three years the patient had undergone three major abdominal operations and a psychoneurotic factor had been suspected.

On examination she appeared healthy: no glands were palpable and no obvious E.N.T. lesion was discovered. A barium swallow meal revealed normal radiographic appearances. On further examination there was palpable a bony projection deep down on the inner side of the mandible lying just in front of the anterior pillar of the fauces. This, at first, was thought to be an exostosis of the mandible but on further opening of the mouth the lump appeared to move in relation to the jaws. From its position a provisional diagnosis of elongated styloid process was made and this was confirmed by a radiograph (*Fig.* 1).

The nature of the condition was explained to the patient, who, being a medical auxiliary, had some knowledge of medical matters. Rather than operate immediately it was decided to keep her under supervision: this has been done for six months and she states that now she is aware of the cause, no treatment is required.

The photograph of a skull with such a prolonged styloid process (although in this case rather shorter) (*Fig.* 2) shows the close relationship of the process to the mandible.

Acknowledgement.—I am indebted to Dr. Selwood Lindsay and to Mr. R. S. McCrea for referring this patient and for permission to publish.

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BOOK REVIEWS

ORTHODONTICS, PRINCIPLES AND PREVENTION. By J. A. Salzmann, D.D.S., F.A.P.H.A., Director, American Board of Orthodontics. 10 × 6¾ in. Pp. 381 + xii, with 262 illustrations and 26 tables. 1957. Philadelphia: J. B. Lippincott Co. (London: Pitman Medical Publishing Co.). £5 5s. 0d.

ORTHODONTICS, PRACTICE AND TECHNICS. By J. A. Salzmann, D.D.S., F.A.P.H.A., Director, American Board of Orthodontics. 10 × 6¾ in. Pp. 496 + xiv, with 471 illustrations and 34 tables. 1957. Philadelphia: J. B. Lippincott Co. (London: Pitman Medical Publishing Co.). £8 0s. 0d.

These companion volumes are in reality a third edition of the author's *Principles of Orthodontics* first published in 1943, with a second edition in 1951. The pages are larger and the format changed from single to double columns of print. Most of the original illustrations are retained with the addition of many others and many additional tables. Some illustrations are not up to standard, e.g. *Fig.* 437 in *Practice and Technics* should have been discarded or replaced and *Fig.* 292 could have been improved.

In the first chapter of *Principles and Prevention* it is emphasized that prophylactic orthodontics, " early treatment of incipient conditions ", is distinct from " late treatment of manifest malocclusion " and requires a " thorough grounding in normal growth and development of the child ". Indeed, most of the space in this volume deals with this subject under various headings, such as: assessment of growth and development; influence of disease; relative growth values; anatomy; function; etc.—and in considerable detail. Aetiological factors are dealt with in two chapters, and the final one is confined to prevention and treatment; it includes simple mechanical and non-mechanical techniques. The second volume, *Practice and Technics*, describes the various fixed and removable techniques, aetiology, classification, and diagnosis.

At the outset it must be said that these books maintain the reputation of the earlier editions as the best reference book available on the subject. The first volume is " written for those whose bent may not be specifically directed towards the exclusive practice of the specialty ". The subject-matter covers the field necessary for one prepared to care for the dental health of children. It achieves its declared purpose with considerable success.

The re-arrangement of the chapters is probably an improvement, and as before numerous references under several headings are appended to each chapter. Aetiology, however, is separated, part in one volume and part in the other. Evolution of the teeth and jaws, originally in different chapters, is wisely brought together, but, although enlarged and improved, still receives less space than such an important subject, albeit often considered of academic interest only, should receive. The result of recent research on nutritional factors, especially pre-natal nutrition and vitamin deficiency, is included. The effect of radiation has been added as an aetiological factor. The aetiology of temporomandibular joint disorders is introduced, but not dealt with completely, since the concomitant aetiological factors, in addition to malocclusion, are not mentioned. In a book on prevention this aspect of the subject is not mentioned.

There is a new chapter on cephalometrics and anthropometrics in which some of the best known techniques are described, but it is by no means complete. This deficiency is partly overcome by the list of references at the end of the chapter. The treatment of this subject is factual, with no attempt to guide the reader in the relative merits of the various techniques. Indeed, this is a major criticism throughout the two books. In addition, the author fails to make a distinction between his own opinion and that of others, and this results partly from a failure in all cases to insert the references in the text. In a few cases a reference is in the text but not in the list

at the end of the chapter, and in one case the author is quoted but his name is not in the index of authors at the end of the book. All this combines to confuse the reader, especially one approaching the subject with little or no previous knowledge of it. The books are, therefore, best suited to those able to read, accept, and reject the material presented.

There must always be criticism as long as there is difference of opinion, and in a work of this nature and size errors and omissions are difficult to avoid but make little or no difference to the value of the books because they are relatively unimportant and the matter and presentation are correct. The whole content of these books loses some of its value by the apparent contradictions which could be easily avoided by greater attention to detail. In order to assist the less informed reader, terms should be defined when first used, or a glossary added. References should be inserted in all relevant parts of the text and listed at the end of the chapter. For example, on page 29 of *Principles and Prevention* allergy is mentioned as a cause of growth failure but no reference is given. Careful scrutiny of the bibliography draws the conclusion that Cohen and Abram (1948) applies, but this may not be so.

Libraries and postgraduates cannot afford to be without this " encyclopaedia ", although its price is high.

H. E. W.

LETTERS TO THE EDITOR

August 1, 1958

Dear Sir,

In Mr. Messing's article on "Linings and their Manipulation" I was surprised to see no mention of zinc oxysulphate cement. I believe a number of practitioners use "Artificial Dentine" but I have never been able to manipulate it successfully as a lining. I have for the last two years or so been using a preparation called "Dropsin", which seems clinically to be a very effective lining. It can be applied with no pressure, either over zinc oxide–eugenol or direct to dentine, and seems to be hard enough to stand the pressure of packing amalgam within a minute or so. It would be interesting to know why this lining was not mentioned—whether there is some objection to it that I have not come across, or whether it is just that zinc phosphate and zinc–eugenol are in more common use.

Yours faithfully,

W. G. Carnegie Dickson

4, *Edgar Buildings*,
Bath.

July 19, 1958

Dear Sir,

In your editorial for June you state that it will be necessary to train dental surgeons in the art of human understanding. This, of course, is a policy in direct contradiction to the present method of training dentists with its emphasis on producing efficient but dehumanized tooth-pluggers, tooth-pushers, and denture-designers. The humane student dislikes filling teeth because he is still aware of the sensitivity of dentine as a human problem and not as a mere research project. He does not make a nice box-shaped cavity in which to park his amalgam, and if he is too humane he may well have to give up dentistry and take to atomic physics. It is doubtful if a conscientious, intelligent, and sensitive student could practise orthodontics without at least a passing twinge in regard to his ignorance and the ultimate value of much of his treatment. Naturally he turns to some of the more infallible teachers for dogmatic assurance. The good dentist under present conditions was often a bad student to whom anatomy was an arid wilderness and bacteriology an inconsequential bore. It would indeed be a good thing if dental technology were taught as an instrument of human understanding and not as an end in itself.

Yours faithfully,

James Scott

Department of Anatomy,
The Queen's University of Belfast.

THE FUTURE FOR ORTHODONTICS

By J. W. SOFTLEY, B.D.S., F.D.S. R.C.S., D.Orth., D.D.O.

FIRST of all I would like to express my thanks to you all for the honour you have done me in electing me your President in this important Jubilee Year of the B.S.S.O.

When I look back at the long line of distinguished men and women who have preceded me I am more than conscious of my own shortcomings. I can only say that I will fulfil the duties of this office to the best of my ability and try not to be too unworthy of those who have gone before.

This is the Jubilee Year of the B.S.S.O. and perhaps on this occasion you would expect from your President an address on a high philosophical plane or perhaps an exposition of some erudite piece of research. However, I have neither the qualifications nor the ability to embark on either of these ambitious projects and, with your indulgence and, I expect, to your relief, I will keep to the level of more ordinary mortals.

Among other meanings for " Jubilee " the dictionary gives it as a year of emancipation, of freedom from legal, social, or intellectual restraints. It is also a year of rejoicing, and we hope to mark it as such during the course of the year and particularly at the May meeting.

To-night I am interested in it as a half-way mark towards the centenary where we can pause and look back, estimate our progress, and, perhaps profiting from the experience of the past, peer a little into the future.

I have chosen the subject "The Future for Orthodontics" because it has been very much in my mind over the past year or two and because whichever way it goes it cannot fail to affect each one of us either directly or indirectly.

If we look back over the fifty years of which this Society can boast, we see change and much progress in orthodontics.

It has shared in the general advance of technology, and the application of new materials and processes have made possible advances in techniques and appliance design undreamed of at the beginning of our history.

More fundamental progress in the realm of real knowledge of certain aspects of our problem is such that anyone starting on an orthodontic career to-day is resting on a much surer foundation than his counterpart of fifty years ago.

That there were many successful orthodontists in earlier years is self-evident, but the many excellent results they achieved were, in most cases, due to an accumulation of clinical experience built up over a period of years rather than to the soundness of their theories.

Clinical experience itself cannot be transmitted to others. Mr. Maxwell Stephens (1928) in his Presidential Address of 1928 said:

"Though we honour ourselves by calling medicine a science, it is far from being a true science and the bulk of knowledge acquired in a lifetime of general experience is personal. It cannot be reduced to a system and set down in finality for others to assimilate."

Brash (1929) in his *Aetiology of Irregularity and Malocclusion of the Teeth* pointed out that very little positive evidence but a great deal of speculation had been produced to support the supposed causes of irregularity and malocclusion. The same charge could have been made, with justification, of attempts to explain results of treatment.

So that when our predecessors came to pass on the fruits of their experience to others they were hampered by the intrinsic difficulty of doing so and, in any case, could only do so in terms of knowledge which prevailed at that time. Sometimes by ascribing (what we now know to be) quite erroneous reasons for their successes it is not surprising that their pupils, in attempting to put theory into practice, fell into traps which long clinical experience had taught the teacher to avoid.

It is not pretended that the ultimate truth is known about all, or indeed any, of our problems, but considerable advances have been made and trial and error need not be the

Presidential Address given at the meeting held on January 13, 1958.

principal means of progress of a person starting orthodontics to-day.

But with all our progress it is vital to preserve a balanced outlook on orthodontics and orthodontic problems. There is no branch of dentistry where it is easier to rise into the clouds and there is no branch of dentistry where it is more important to have both feet firmly planted on the ground.

Orthodontics is not an exact science and it never can be. It must always lie somewhere between a science and an art. This has always been realized, I think, on this side of the Atlantic but not on the other, so that although, only half our history ago, Weinberger (1926) in the preface to his book on the history of orthodontics could say: "Orthodontics to-day is more nearly an exact science than any other branch of dentistry or possibly medicine . . .", there would be few in Europe who would agree with him then, and I doubt if he would be able to find one to-day.

Many attempts have been made to accept the science and to discount the art—to make a series of measurements, to apply a set of rules with the idea that by so doing a positive answer for successful treatment would automatically emerge, which (and this is important) could be applied by anyone acquiring a certain standard of technical ability.

It is interesting to speculate on the implication of the research outlined in the last Northcroft Lecture, but we should not imagine that the old-fashioned virtues of judgement and experience are likely to be ousted by sets of tables in the foreseeable future.

Attempts to practise orthodontics as a pure technology have always failed in the past and will always fail in the future. It is a professional occupation in the truest sense of the word, requiring not only knowledge but the ability to assess evidence, to come to a reasoned conclusion on that evidence, and to profit from experience. A sound theoretical background is an important adjunct to successful practice. It is not, and it cannot be, a substitute for clinical experience.

In the very nature of things clinical experience in orthodontics cannot be acquired overnight. Our predecessors built it up over a period of years. We should do better because our level of real knowledge is higher and our facilities for acquiring knowledge are better, but it is not possible to hurry the growth of patients. It is from the 16-, 17-, and 18-year-olds that the success or failure of treatment is learned.

Some reasonable continuity of experience in one place is desirable so that the results of one's own treatment can be seen and this has to be balanced against the value of moving around and obtaining other points of view. Without question private practice, where one stands or falls by one's own efforts, is the quickest way of obtaining experience.

There are those who take the view that dentistry is a small subject and that dental surgeons should be able to deal with it in all its branches including orthodontics. This is to ignore the lessons of the past and the clear evidence of the present.

The history of medicine, of which dentistry is a part, clearly shows the evolutionary trend towards specialization. There is always a stage where the demand for specialized knowledge exists but where the number of people trained to satisfy that demand is insufficient. Orthodontics is at that stage now, and until there are enough orthodontists to satisfy the demand the general practitioner is expected to deal with some of its problems.

The trend towards specialization has been going on since the beginning of the century, but the introduction of the Health Service, by unleashing an unprecedented demand for orthodontics, has focused attention on the shortage of trained people. As a direct consequence of this we have witnessed the rapid expansion of our speciality in the socialized field by the appointment of a number of Consultant Orthodontists.

The pattern of these appointments was intended to be set by similar ones in other fields, where a consultant advises and whenever necessary treats, either by himself or with the aid of the facilities at his command.

Like other specialities orthodontics produces problems peculiarly its own. There is a wide difference, for example, between the demands of ophthalmology and orthopædics. But the

only essential difference between orthodontics and other specialities is that at present the demand for its services is far in excess of the facilities available to satisfy them.

This state of affairs is likely to persist for some time. Already the expansion of the consultant service threatens to outrun the supply of competent orthodontists with the requisite clinical experience, and it will be no service to the community or to the profession to lower the standards.

I would remind you of the *Report of the Advisory Committee on Post Graduate Dental Education* (1947) where, referring to Consultants, it says that the status of Consultants in the sense understood in medicine is the product less of special training than of aptitude and experience.

As to why these appointments have been made, we should disabuse ourselves of the idea that the immense benefits we confer on the human race have at last been recognized. The truth, alas, is more likely to be that authority, confronted with concrete evidence of the failure of much orthodontic treatment, is making these appointments in the hope of saving money.

It is not suggested that failure in other branches of medicine is less common than in orthodontics, but irrefutable evidence is not so easy to produce.

And failure itself must be put into perspective. But orthodontists are not yet in a position of being able to predict the growth of individuals nor to predict the individual response to a particular stimulus. Consequently not all cases can be expected to succeed even when dealt with by experts.

The public are sometimes led to expect too much by ill-informed medical, and, I regret to say, dental, opinion which looks upon orthodontics as a simple matter of tooth movement.

But however rationally we may explain some of the failures, we should not be complacent, nor is it wise to ignore public opinion.

So that paradoxically it is to the failures of orthodontic treatment rather than to its successes that we owe the present official interest and the present expansion in our speciality.

The main reasons for failure are:—

1. Because socialized dentistry has unleashed a demand for orthodontic treatment far greater than the capacity of trained people to supply it.

2. Because the training is essentially a postgraduate study.

3. Because the teaching of the majority of those in private practice who are attempting to treat orthodontic cases was inadequate.

There is no doubt that teaching has improved, particularly in the post-war years. This is, in no small measure, due to the appointment of full-time teachers. They, by being able to give their whole time to teaching problems, have done extremely good work. In some cases they have been able to add to the store of knowledge, but it should be recognized that a good research worker is not of necessity a good teacher and the reverse is no less true.

There is also a price to pay for the success of full-time teachers. Part of that price is that by encouraging early specialization, general experience in broader fields is reduced, and as Mr. Maxwell Stephens (1928) said in the address I have already quoted, "... there is the ever-present danger that the part may shut out the whole".

This is a danger against which we must guard and it can be done only by keeping the basis of education as broad as possible.

The truth of this has been recognized by the Nuffield Foundation in the facilities which it has made available for teachers to study basic sciences. Their wider and more liberal outlook cannot fail to have a beneficial effect on the teaching of dentistry.

There is also a place, and a very real place, for the retention of some part-time teachers in dentistry and particularly in orthodontics so that they may keep, not only students but the full-time teachers, in contact with the experiences and problems of practice.

It is unfortunately true that while the present-day student has better opportunity for learning, the experience of many teachers and examiners is that they often fail to take advantage of their opportunities.

Mr. Hovell (1956) pointed to one of the reasons in his address of 1956 when he

reminded us that orthodontics does not always figure in examinations and that as the main object of an undergraduate is to qualify he tends to ignore anything not essential to that aim.

A Committee of this Society, reporting in 1922 and 1925, made the same point and said that the student qualified knowing less of orthodontics than of any other branch of dentistry. I fear this may very well be still true. Dental education in this country is not without tradition, and while tradition is often colourful and always interesting, it sometimes hampers progress in dentistry as in other fields.

My experience in the Dental School in Malaya, then only a few years old, showed to me the value of this fresher unhampered outlook on the presentation of dental subjects.

A great service could be done to orthodontics, and to dentistry as a whole, by a reshaping of the undergraduate curriculum—keeping and extending the tradition of association with medicine, giving more adequate instruction in basic sciences, dealing more imaginatively and less traditionally with such subjects as dental anatomy, so that the dental surgeon could see the orthodontic problems of practice in a truer perspective and not as mechanical exercises in tooth movement.

There might very well be fewer orthodontic cases tackled by the general practitioner, but those with more success.

However, I do not believe that orthodontics can be taught effectively to undergraduates and it must remain a postgraduate study.

While these proposals are designed to affect the outlook of future generations of dental surgeons we are obliged to deal with problems of the present.

There are very distinct problems when a consultant advises a dental surgeon on an orthodontic case. Success depends on a close understanding between the two people. The operator must interpret the orthodontist's meanings correctly and be able to put them into practice. He must also have sufficient knowledge of basic principles to know when a change of plan may be desirable.

It is usually reasonably easy to decide on the initial steps of treatment, but subsequent procedures depend on the response and any treatment plan drawn up at the start can only be tentative.

The alternative of exercising strict supervision over all stages of treatment defeats its own object—besides reducing the operator to the status of a robot carrying out procedures without understanding.

So one of the functions of a consultant is to replace the deficiencies of past teaching and to lead his flock of dental practitioners on to straighter if less expansive paths.

But however successful his efforts it will not affect the problem of dealing with the number of malocclusions, and this should be made perfectly clear to those in authority.

Another inquiry which this Society sponsored was into the need for orthodontists, and it was concluded that a trained orthodontist working full time could deal with 250 new cases of all types each year, giving a total of about 600–650 cases under treatment. For a five-day week this works out roughly at one new patient for every day of practice.

While many trained people can deal with more than this number, particularly if the clinic or practice is organized to treat them with trained ancillaries and so on, it is reasonable to say that general practitioners are unlikely to do so. So that if a general practitioner can give up one day a week from practice he will probably not be able to take on more than 50 cases per year.

He can only do this at the expense of a far larger number of his other patients, and if we accept current opinion, the number of active practitioners is likely to decline sharply in the next few years. Therefore with the best will in the world general practitioners are unlikely to be able to increase their contribution to the orthodontic problem.

Similar arguments apply to the school dental service. School Dental Officers can only make an effective contribution to the treatment of malocclusions at the expense of their other duties. As this service is grossly understaffed at present it would appear senseless to divert effort away from its main purpose.

This is not to say that the general practitioner and the school dental officer have no

contribution to make. One cannot be a consultant orthodontist for long without being aware of the enormous amount of orthodontic effort which is being wasted on patients who do not appreciate it, and in many cases do not even want it.

Their contribution does not lie so much in teaching them to make appliances for more and more patients, but in ensuring that the facilities which are available at present are not wasted. This means much greater care in selection of patients than is now being exercised.

In assessing the need for orthodontists it is important not to base the estimate on the number of malocclusions but on the number of malocclusions which should be treated. Any saving in resources would be much better spent on teaching the younger generation to take care of the teeth they have or to developing the school dental service.

However desirable orthodontics may be, it is essential to preserve a balanced outlook and admit that an orthodontic service should only be superimposed on the foundation of an efficient dental service and on a population which will care for its teeth.

I have tried to show that general practitioners would be unable to make much impression on the number of orthodontic cases requiring treatment even if the desire to do so was there.

My experience convinces me that only a small minority of them do wish to treat cases and that the remainder would be quite content to get rid of all, or of all but the simplest, of their orthodontic problems.

The consultant is of value to those who are already interested and who consult him and possibly with his help they may treat a few more patients. He is of value to the remainder only in so far as he can take cases off their hands. To believe that the appointment of consultants will enable practitioners to treat a number of cases which they never did before is merely wishful thinking, and it appears to be worse than useless to advise treatment where the practitioner is unable or unwilling to carry it out.

I have dealt with the problems of the consultant orthodontist at some length because it is likely that the future for orthodontics in this country will depend on the way this service is developed. The appointments which have been made so far are not ends in themselves; they solve very few problems.

The closer the problems are examined the more irresistible is the conclusion that in the Health Service in this country orthodontics will most likely be dealt with by a full-time service.

The ultimate level of the service will depend on how much the country can afford to spend and that will depend on how much value it obtains for the money.

I therefore believe that what is required at present is not a scattering of orthodontic effort over the whole country but a concentration and development in the areas where appointments have already been made so that real service can be given. The experience so gained can be gradually extended and experienced people will be available.

By all means encourage the general practitioner experience which is available, by the creation of such posts as clinical assistants, but the training of general practitioners should not be the ultimate aim, for in essence this is an attempt to substitute the consultant for the rule of thumb, which has proved disastrous before.

Socialized dentistry in this country has been characterized by an attempt to do too much with too little resources, to dissipate effort with the result that little has been achieved for the effort which has been expended. Let us at least give warning to avoid this mistake in orthodontics.

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DISCUSSION

Mr. G. C. Dickson said that he would like to thank Mr. Softley for asking him to open the discussion on his address and for letting him have a copy of it a week or two in advance. He had read it through three or four times and there was a good deal in it with which he wholeheartedly agreed. There were, however, certain aspects of it on which he would like to comment.

He could not help feeling, although he might be wrong, that Mr. Softley had rather dwelt on the necessity for experience. He would be the last person to say that experience was not necessary but it depended upon what was meant by experience. A man could do the same thing wrongly for thirty years and call it experience. Experience was essentially the subconscious pigeon-holing of little facts and items of information about a patient and his response to treatment which could eventually be drawn upon in treating subsequent patients. He thought that there was no theoretical reason why eventually orthodontics should not become a science. He said "theoretical" because there was obviously the practical limitation that they were unlikely to find a mind, without experience, which could assimilate all those facts.

He would like to quote from a recent essay by Sir Julian Huxley, written under the title "Science in a Free World". "History demonstrates that the best method for securing advance and improvement in awareness and so for securing human progress in general is the scientific method—in other words, going into facts, questioning them, framing hypotheses about them, testing hypotheses against the facts. It is through this dialectic exchange between brute fact and human reason that we discover new facts and new regularities which lead on in their turn to new hypotheses and new discoveries and to a gradually increasing body of ever more firmly established truth."

That had not been written about orthodontics, but it could well have been and orthodontic thought was now proceeding on those lines. He would like to put in a plea for that approach. He fully realized that at the moment experience must play a very large part in the training of the orthodontist but he hoped that in the future it might play a lesser part.

There were two other points in the paper on which he would like to comment. One was simply the statement of the bald fact that Mr. Softley thought that the general practitioner could treat very few orthodontic cases. He confessed that although the number was obviously limited, his experience as an orthodontic consultant had been more heartening in recent years in that respect. He thought dentists, particularly those who had qualified since the war, could take on an appreciable number of cases and that, of course, brought him to the second point, which was that the thing that those in the hospital service felt that they lacked most of all was about six pairs of hands.

There was, as Mr. Softley had said, a large number of cases to treat, but he would put it to him that the training of the orthodontist was very largely mental and that the practical training could be compressed into a small number of years. The practical training was a question of manual dexterity which could be acquired in a shorter time. Therefore, in order to make the best use of the available material he thought that use should be made of other people's hands.

Mr. Softly had mentioned that he approved of clinical assistants. A couple of years ago, when he himself had opened the discussion on Mr. Hooper's paper, he had been criticized for suggesting the appointment of senior hospital dental officers. Some people might not know what was meant by the term "clinical assistant", but essentially it was a grade of appointment used a lot in the hospital service in which a general practitioner came into a specialized clinic to assist the specialist on a part-time basis, usually for one or two sessions a week. In that way not only was the orthodontist able to have the use of someone else's hand to treat his cases but he was training a potential assistant—a practitioner to whom he could refer cases for treatment with confidence. He would like to ask Mr. Softley whether he did not consider that expansion on the lines of clinical assistants might be of value.

There was one further point which he would like to make. He often felt when he was standing and waiting for Zelex to set that the taking of impressions and the making of bands were mechanical procedures and that apart from the physical exercise and the mental relaxation involved there was no value in doing those things. He wondered what Mr. Softley thought of the suggestion of using dental ancillaries for taking impressions and making bands.

The President, in reply, said that he had made a point when speaking about experience, that it was not only experience but the ability to profit from it which was of importance. He agreed that people could do the same thing wrongly for thirty years and therefore suggested the value of moving around and getting other ideas. If a person could not profit from experience he would be no good at orthodontics or at anything else.

While he agreed that practical training could be compressed to a certain extent there was nevertheless a limit beyond which it could not be compressed. His experience of teaching and of people doing postgraduate work was that it took at least a year or so before the pennies began to drop. The first year merely increased the confusion and only gradually was that confusion dispelled. He agreed about the value of the scientific method of approach, and clearly many of the problems would have to be solved that way, but people had to practise orthodontics and the people who were applying the scientific method were in the main people who were doing research.

He was glad that Mr. Dickson was more optimistic than he was himself about the contribution which the general practitioner could make. He had recently tried to find out what had happened to a number of cases he had seen in one area. He had found that 25 per cent, or something over, of the cases which he had seen and for which he had advised treatment, had in fact received no treatment for various reasons, usually because the patient had not come back or had decided not to proceed. The important point was care in the selection of patients.

He would be entirely in favour of clinical assistants. They had, in the foreseeable future, a great part to play, but he would emphasize that in his view it was a limited part and that they could not in fact deal with the orthodontic problem of dealing with the mass of people who were clamouring for treatment. He did not think that it could be done that way.

He supported the idea of dental ancillaries.

Dr. W. R. Burston said that he hoped he would be forgiven if he prefaced his remarks with one or two personal observations. He and his colleagues in Liverpool took great pleasure and not a little pride in seeing their old chief, Mr. Softley, in the position which he at present occupied. He was, alas, no longer with them at Liverpool but he had left with them a fine tradition of service. Dr. Burston was more than indebted to Mr. Softley for all he had done for him during the time he was privileged to serve as his second in command.

He would like to comment on one or two points in Mr. Softley's address. The first point was the question of orthodontics as an art and as a science. Science had come to be regarded as something "exact", but surely the "degree of exactitude" that could be achieved in any given problem was determined by the precision with which that problem could be stated. Even a subject such as Physics was now having to recognize this fundamental limitation. How much more true was it then of biological science where it was extremely difficult to state a problem in precise and meaningful terms. In orthodontics most of our terms were qualitative and arbitrary, bearing little relation to the vital processes involved in growth. How then could it be hoped, as had often been tried, to resolve clinical problems with the exactitude of a mathematical equation? Surely this was where Science failed in the solution of clinical problems and Art stepped in.

The President had reviewed the last fifty years in orthodontics and it was interesting to compare this with the history of morphology. Down the ages morphology had recognized two schools of thought—the formal and the functional. Formal morphology based its study of development on the concept of the "archetype"—the common plan—to which all animal form tended.

The absurdities which the logical extension of this concept achieved were there for all to read in the writings of the German school of transcendental anatomy. Philosophically speaking there was not one whit of difference between formal morphology and the concept of idealized occlusion and idealized skeletal form. In that sense orthodontics had recapitulated in fifty years what morphology had passed through in 2500 years.

On the other hand, functional morphology was more concerned with the means by which form was attained. It dealt with the way in which the various tissues interact —the correlation of the parts—the concept of the whole of an individual organism balanced not only with its environment but more particularly within itself. Surely this was the heart of the orthodontic problem. What was constant from individual to individual was the methods Nature used in progressing from stage to stage in development. An understanding of these "developmental horizons", not only within the jaws, but also in the body as a whole, would go far to solving many orthodontic problems. Orthodontists were privileged, as were few others, to witness development taking place, since the teeth and jaws had such an extensive post-natal development as compared with other organs of the body. It was their main task to study the interplay of the various tissues and how this could be modified to produce a desired result.

One of the principal difficulties was the confused orthodontic terminology which clouded the real nature of clinical problems. So many clinical clichés were in use —a form of shorthand, which in many cases had a variety of interpretations—that a precise statement in these terms was impossible. The speaker had tried explaining orthodontic problems to students in the simple terms of anatomy. This had been a very interesting experiment from his point of view because he had seen how the paucity of knowledge was covered up by the use of clichés. Once such terms as "post normal case" or "Class II case", etc., were forbidden it was amazing how much more thought and care were required in describing a given condition and how the real nature of the problem became apparent.

Turning to the practical aspect of orthodontics and in particular to treatment for the masses, the overriding problem in the Liverpool area was of first securing effective general dental treatment, without which orthodontic treatment was largely a waste of time and effort.

With regard to individual consultants working with large numbers of general practitioners, his own view was that unless an individual was looking after a patient all the time and seeing development taking place, the case could not be treated effectively. Many orthodontists found that they had to modify treatment in consequence of an original failure to assess developmental possibilities correctly. It was very difficult to see patients at irregular intervals and at the same time get to grips with what was taking place. For that reason he did not think that one orthodontist could cope with very large numbers of patients.

He would like to thank Mr. Softley for his most interesting and instructive address.

Mr. J. H. Hovell, after thanking Mr. Softley for his address, said that when he himself had given a Presidential Address, discussion had been stifled by the proposer and seconder of the vote of thanks who said that presidential addresses should not be discussed. He personally did not propose to disappoint Mr. Softley in the same way.

He disagreed with a great deal of what Mr. Softley had said regarding the future of orthodontic consultants. In fact he thought that the President had contradicted himself. In the first place he had said that he thought orthodontics would be better taught in the schools and then he had said that it was a postgraduate specialty and not an undergraduate one. He could not have it both ways. Either it was taught in the schools or it was part of the postgraduate system. Physiology, anatomy, comparative anatomy, and orthodontics were the basis of the teaching of the whole of dentistry. He did not think that general dental diagnosis and treatment planning could be taught properly unless orthodontic diagnosis, which was the basis of the former, was also taught to the dental student. When qualified the dental student had to know all that he could be taught about orthodontics in that respect.

With regard to treatment he agreed with what had been said by Mr. Dickson. He thought that treatment was technique. The actual construction of orthodontic appliances, whether fixed or removable, was far simpler than the construction of bridges and jacket crowns. That general dental surgeons should not be encouraged to take part in the orthodontic service he did not believe. The fact that the majority of those who qualified before the war had no knowledge of present-day orthodontic diagnosis and treatment was no argument against including orthodontics in what the dental surgeon of the future could do. He thought that any consultant who did not in his area encourage an interest in orthodontics and did not give talks and organize study groups was failing in his duty as a consultant orthodontist.

The President, in reply, said that he was aware of the apparent contradiction in what he had said but he did

not think that in fact it was so. He believed that great improvement could be made in the teaching of orthodontics in schools and he believed that from that the practitioner would be able to appreciate the problems of orthodontics. But that was a far cry from dealing with the orthodontic problem and he still maintained that the general practitioner was not capable of dealing with the mass of orthodontic cases which expected treatment.

He agreed that technique itself was comparatively simple. Some techniques were more difficult than others, but the application of those techniques was not easy. His experience of post-war students was that although they were a little better than the pre-war ones he did not think they were capable of dealing with complex orthodontic problems. He felt absolutely certain of that.

Mr. S. G. McCallin said that he enjoyed the President's address very much. Following on what had been said by Mr. Hovell he would like to support his contention that general practitioners should be in a position to call upon a consultant to receive assistance on diagnosis and treatment planning. In the past ten years he had dealt with large numbers of cases, referred to him by practitioners, at the Eastman Dental Hospital, and while it was true that as the years went by many of these practitioners fell away and did not refer further cases, this might be his fault since he probably prescribed treatments which were beyond them to carry out. Nevertheless a hard core of interested general practitioners was beginning to emerge who sent more and more cases for opinions and evidence was growing that they obtained good results.

He would also like to support Mr. Hovell's point that a regional consultant was not only obliged to see large numbers of referred cases but also to encourage interested general practitioners in his area. In his view, with the right encouragement many of these general practitioners would enjoy doing exceedingly good work.

Mr. Dickson had pointed out how difficult it was for a student who had acquired some theoretical knowledge to obtain a post where he could gain practical experience. It seemed to him that opportunities should be created for a man who has spent perhaps two years studying, to gain further experience under partial supervision. Possibly more senior registrar appointments might solve this problem. There was no real substitute for prolonged clinical experience especially if regional consultants were going to be able to assist general practitioners in their area with their practical problems.

The President, in reply, said that he was sorry but he could give no assurance at all on that point. He had no idea whether in fact by to-morrow the powers that be would not say that orthodontics was not to be practised by the general practitioner. He appreciated the amount of good work which people who had specialized over a long period were doing. Of course, it was those people in particular that the consultant orthodontist could help with their problems. A great many people did in fact come along and bring their cases and ask about them and it appeared that they derived considerable help from so doing.

Mr. J. F. Pilbeam said that he would like to join the other speakers in expressing grateful thanks to the President for his excellent Presidential Address.

Reference had been made in the address to the tremendous magnitude of the problem of providing orthodontic treatment for the masses but it had seemed to him, at any rate in the past two years, that orthodontists had given so much time to deciding many cases were untreatable that the problem was solving itself.

In his opening remarks the President had referred to consultant appointments in the Regional Hospital Board Service and he had implied that that was a natural thing to expect to follow the setting up of a socialized service. Personally, he did not think that it had been quite so simple as that. Those who had been interested in encouraging the setting up of a consultant orthodontic service in the Regional Hospital Board Areas would agree with him when he said that it had been a very uphill and difficult task to establish such appointments. A tremendous amount of hard work had had to be put in to get those appointments and, indeed, to get orthodontics considered as a specialty at all. As a result of a great deal of effort through the Society there had come the considerable achievement of establishing orthodontics as a consultant specialty, recognized as such by the Ministry of Health.

This ideal had been foreseen in a Report published by the Society as long ago as 1942. It was very pleasant to see that the recommendations put forward in that Report had at last been implemented, not as a means of saving money as our President suggested, but because orthodontics had established itself as a true specialty of dentistry.

The President had also referred to dental education and orthodontics. The Report to which he had just referred had mentioned the question of the teaching of orthodontics in the schools and the majority recommendation was that the teaching of orthodontics in schools should be very limited indeed—limited to the teaching of simple diagnosis so that the student was left, when he qualified, to seek other means through postgraduate training for further education in orthodontics if he so desired.

After meeting a large number of students who had qualified and who had come from schools which had adopted that recommendation and also from schools which had not, he would throw in his weight with those schools which did not teach orthodontics. He thought that students had become better orthodontists when they had trained by means of postgraduate courses.

He was very disappointed that the President felt that the general dental practitioner could not play a very important part in the development of the orthodontic service. Personally he would have thought that the consultant orthodontist could have utilized the keenness that was very evident with a large number of practitioners, by appointing clinical assistants for two years and so develop a service which would encourage a large number of dental surgeons to be interested and also to do a certain amount of work under consultant guidance. If there was some regularity about it he thought that the consultant could treat a tremendous number of patients with the help of the general practitioners.

He hoped that in the field of orthodontics, without having too many extravagant ideas, they would eventually have house surgeons, registrars, and senior registrars in the hospital departments so that through the Regional Hospital Boards hospitals more orthodontists could be trained to fill the larger number of vacancies which would arise in the next few years.

While on the subject of the training of orthodontists he would like to say it was a little disappointing that the Eastman Dental Hospital, set up a few years ago as a

dental postgraduate centre, had trained so few people in orthodontics. He hoped that that deficiency would be made good eventually by means of Regional Hospital Boards training their own consultants.

Lastly, he would refer to the question of selection of patients. He thought he could claim to have had some experience in the organization of orthodontic services in various fields and he had always said, and he knew that a lot of people who worked with him agreed, that orthodontic treatment should not be undertaken unless there was complete co-operation between the child and the parent. The best way of finding out whether there would be such co-operation was to ask the parent "Are you concerned about your child's appearance?" If the mother was not concerned then that child would not be a suitable one to treat. By means of that simple method of selection it was possible to reject a number of children who would probably prove to be unsuitable patients.

The President, in reply, said that possibly he had taken a rather more cynical view of some of the problems than the speaker would have liked. He had been interested to hear from Mr. Pilbeam, who had been concerned with the appointments in the Regional Hospital Board Service, of the fight there had been to create a consultant service. So far as he could understand it Mr. Hovell did not want orthodontics to be a consultant service but wanted the general practitioner to deal with all cases. Again, it was not possible to have it both ways. It was either easy, in which case anyone could do it, or it was difficult.

He agreed that use should be made of the general practitioners who were willing and able to deal with orthodontics, and that they should be encouraged. He had not intended to imply that that should not be done. He considered that such people should be used and the consultant must help them. Nevertheless he did not think that the whole of the problem could be met by the general practitioner. He agreed entirely that other grades such as that of registrars should be appointed in the hospital service as well as consultants. He did not think that there should be consultants only.

Mr. J. C. Ritchie said that he had very much enjoyed the President's address, because he felt that his feet were planted so firmly on the ground. There was just one appeal which he would like to make and that was that in teaching orthodontics, both undergraduate and postgraduate, those who taught should not have their vision clouded by the present era of socialized dentistry. It was only by workers in the orthodontic field exploring new avenues, that progress would be made. If teachers took the view that it was no use teaching a certain thing because the Dental Estimates Board would not approve, they would be going backwards. A great deal was heard at the present time of difficulty and frustration among practitioners. In their teaching of orthodontics they must keep their view absolutely clear and unfettered by Government control.

Mr. G. C. Dickson said that it was only in recent years that it had been customary to discuss the Presidential Address. There was, however, a rather older custom, which it fell upon him to carry out that evening, and that was to propose a vote of thanks to the President for his address.

Mr. Softley, of course, was no stranger to members. While he was in Liverpool and travelling was difficult they had not seen as much of him as they did now that he was at Oxford. He was now Orthodontic Consultant to the Oxford Regional Hospital Board and he had developed the orthodontic service in that area. He would like to say on behalf of the members how pleased they were to be able to look forward in the jubilee year to Mr. Softley's penetrating thought and urbane wit from the President's chair. It was with great pleasure that he proposed the vote of thanks.

The vote of thanks was carried with acclamation.

Lichen Planus of the Mouth

It is well recognized that lesions in the mouth can often be demonstrated in cases of cutaneous lichen planus. However, it does not seem to be generally realized that lichen planus can occur in the mouth without any cutaneous eruption. The condition can be symptomless, the mouth lesions being noticed by the doctor or the dentist. On the other hand, patients may complain of roughness or dryness or of a metallic taste. If it becomes ulcerated, pain is the prominent symptom. Periods of dysphagia may also be present.

Patients gave a history of nervous breakdowns, persistent insomnia, or depression, and most of them appeared to be of a nervous, sensitive temperament. A few had major worries or strain immediately prior to the onset, while others had suffered previously from peptic ulceration.

The areas affected were the inner aspect of the cheek, tongue, lips, gum margins, and palate and fauces. The commonest sites for the lesions were opposite the occlusal line on the cheek mucosa, on the dorsum and posterior margins of the tongue, and close to but just short of the gum margins.

Lesions consisted either of discrete or confluent white spots of pin-head size, white streaks or white patches up to 2 cms. in diameter. There is no specific treatment of the condition. Explanation and re-assurance, simple psychotherapy, and the use of sedatives and other general supportive treatments have been employed. It is clearly important to reduce trauma from sharp teeth or rough dentures, particularly in cases with ulceration. The development of carcinoma on the site of lichen planus must be very rare.—Warin, R. P., Crabb, H. S. M., and Darling, A. I. (1958), *Brit. med. J.*, **1**, 983.

THE DEVELOPMENT OF THE JAWS

By **ANDREW D. DIXON,** M.D.S., B.Sc., Ph.D.
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THE progress of dental science can be assessed in two ways: first, by advances in the treatment of oral disease and, secondly, by the extent of the knowledge, both of a functional and aetiological nature, which enables us to explain the treatment of the abnormal on a rational basis. Thus, the underlying reason for a consideration of the manner in which the bones of the facial skeleton differentiate, develop, and grow is that knowledge of these processes is essential for a fuller understanding of abnormal development of this region of the skull.

The development and growth of the jaws are best considered as two distinct stages in the attainment of their adult form. Growth of the jaws is a complex problem intimately concerned with the aetiology of malocclusion and an extensive literature exists which attempts to classify the various causative factors predisposing towards these deviations from the normal. It is not the intention of this paper to extend this aspect of the problem.

Fortunately, before the jaws can grow they must develop, and the stages in their development can be described much more precisely and inferences more readily determined. In scope, the present paper is therefore confined almost entirely to the early developmental history of the jaws and some applications of this knowledge to the aetiology of dental disorders.

A considerable literature may be found which deals with the development of the mandible, doubtless because of its relatively simple form and lack of complex morphological relationships with other skull elements. In contrast, reference in the literature to the development of the upper jaw is more limited (Dixon, 1953). This has resulted in a persistent emphasis on the developmental history of the lower jaw and the consideration of the two jaws as quite separate entities.

This occasion affords an opportunity to study the jaws as a single developmental and functional unit, bringing to light certain significant and comparable patterns of development which the study of one bone only might overlook. Furthermore, it will be of interest to note the relationships of the jaws to structures most closely associated with them during their development, namely, nerves, cartilaginous elements, and the dental lamina and tooth germs. Although we cannot hope to obtain conclusive evidence without experimentation we may see whether or not the developmental pattern supports the hypothesis that the early differentiation of the jaws is induced by such structures.

FEATURES OF FACIAL DEVELOPMENT

The embryological processes which make up the soft tissues of the human face are the mandibular, maxillary, and frontonasal processes. Fusion between them by disintegration of their ectodermal coverings normally occurs early in embryonic life, before ossification of the jaws begins. It is extremely difficult, therefore, particularly in the case of the upper jaw, to relate the boundaries of these processes to the position of ossific centres. Although some authorities (e.g., Arey, 1953) maintain that the philtrum or median part of the upper lip is formed by the lower part of the frontonasal process, it is now generally accepted that the maxillary processes meet one another in the midline, the lower part of the frontonasal process being submerged beneath them. Boyd (1933) provided adequate evidence for this concept from an embryological study of the upper lip in a number of mammals.

Typical coronal sections through the facial region of human embryos, best represented by a diagram (*Fig.* 1), show key structures to which frequent reference will be made throughout the paper. At the top of the diagram are

Given at the meeting held on February 10, 1958.

the forebrain vesicles, which later will differentiate into the lateral ventricles of the cerebral hemispheres. Just below them the mesodermal septal process with its ectodermal covering projects downwards into the common oronasal cavity, contains the cartilaginous

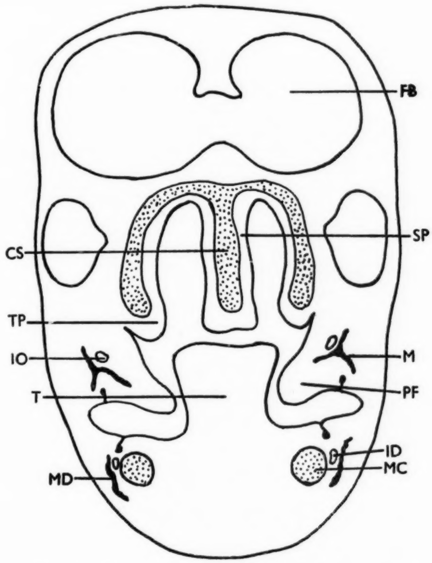


Fig. 1.—Camera lucida drawing showing key structures in a coronal section through the facial region of a human embryo. CS, Cartilaginous nasal septum; FB, Fore-brain vesicle; ID, Inferior dental nerve; IO, Infra-orbital nerve; M, Maxilla; MC, Meckel's cartilage; MD, Mandible; PF, Palatal fold; SP, Septal process; T, Tongue; TP, Turbinate process.

nasal septum, and ends a short distance above the dorsum of the tongue. The upper extremity of the cartilaginous septum continues first laterally above the oronasal cavity and then downwards to form the lateral wall of the nasal capsule, terminating in the substance of the inferior turbinate process. At once one readily obtains the impression that the nasal capsule as a whole is maintaining the patency of the respiratory part of the oronasal cavity and is acting as the primitive skeletal support for the upper face.

The soft tissue palatal folds at present project downwards at the sides of the tongue but will later pass inwards above it to fuse with each other and the inferior border of the septal process. In the central part of the maxillary process, at the base of the palatal fold, the maxilla is at an early stage of its development, forming a small bony mass in relation to the infra-orbital branch of the trigeminal nerve.

At the same time in the mandibular process the mandible is becoming established in relation to the inferior dental nerve, on the lateral aspect of Meckel's cartilage, which forms the primitive skeleton for the lower jaw.

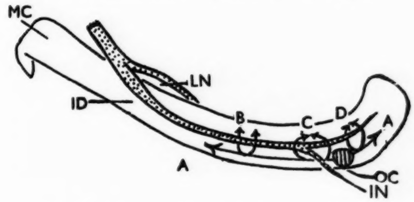


Fig. 2.—Diagram showing the centre of ossification of the mandible and the directions in which bone spreads from this centre. ID, Inferior dental nerve; IN, Incisive nerve; LN, Lingual nerve; MC, Meckel's cartilage; OC, Centre of ossification. For explanation of A–D *see* text.

DEVELOPMENT OF THE MANDIBLE

The inferior dental nerve crosses the superior, or cephalic, surface of Meckel's cartilage (*Fig.* 2) and passes forwards on its lateral aspect to divide into terminal mental and incisive branches a short distance from the enlarged anterior extremity of the cartilage. About the 15-mm. C.R. length stage, or during the sixth week of intra-uterine life, a centre of ossification appears in the angle formed by the mental and incisive branches of the main nerve trunk. From this centre (OC) bone formation spreads rapidly (A) forwards towards the midline and backwards along the outer side of the cartilage, forming a bony shelf below the inferior dental nerve and its branches. The appearance of the ossific centre is of an intramembranous nature and is quite divorced at this stage from Meckel's cartilage. Histological sections from a 15-mm. C.R. length embryo show the ossific centre in the coronal plane below and between the mental and incisive nerves (*Fig.* 3).

Mesodermal cells form a condensation in the midst of which small islands of osteoid tissue accumulate. In this embryo there is a marked increase in the vascularity of the ossification zone, and the oral epithelium can be seen at the top of the photograph (*Fig.* 3).

Bone development not only spreads rapidly in an anteroposterior direction, but also

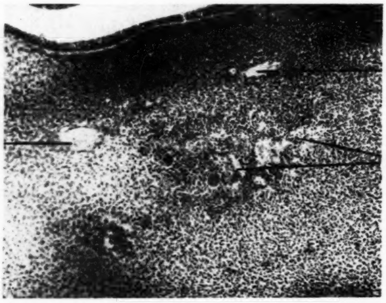


Fig. 3.—Coronal section through the centre of ossification (OC) of the mandible in a 15-mm. C.R. length human embryo. IN, Incisive nerve; MN, Mental nerve.

upwards on the lingual and buccal aspects of the nerves to form a trough or gutter around them (B, *Fig.* 2). The buccal plate becomes divided to pass around the mental nerve but closes again above it, thus completing the formation of the mental foramen (C, *Fig.* 2). In front of this region the outer and inner plates approach one another over the incisive nerve, eventually forming a tunnel or canal in which the nerve lies (D, *Fig.* 2). Coincidently the mandibular bone begins to envelop Meckel's cartilage on its upper and lower surfaces. Horizontal sections through the mandibular process of a 33-mm. embryo (*Fig.* 4) indicate the anteroposterior extent of the mandible. The buccal plate, which is extremely thin, follows the curvature of Meckel's cartilage but is separated from it, in this section, by the inferior dental nerve. Towards the future symphysial region both walls of the neural gutter are visible. Already the musculature of the tongue is well differentiated, the lingual nerve passes forwards along the inner side of Meckel's cartilage, and on the outer side of the mandible the masseter muscle is sharply defined.

In this manner the primary or neural element of the mandible is established, which will give rise in later life to the greater part of that substance of the lower jaw termed the basal bone. One must emphasize again its close relationship to the nerves of the mandibular process and its dependence for its form on Meckel's cartilage.

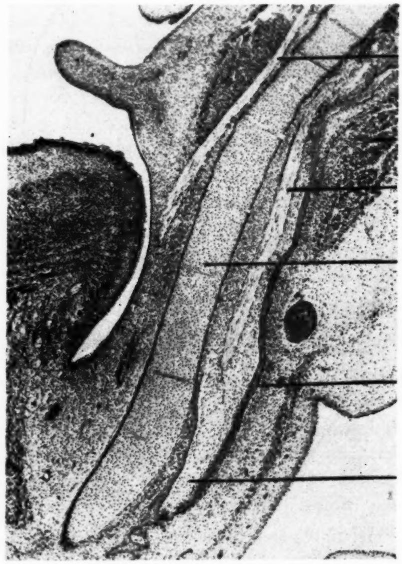


Fig. 4.—Horizontal section through the mandibular region of a 33-mm. C.R. length human embryo. ID, Inferior dental nerve; LN, Lingual nerve; MC, Meckel's cartilage; MD, Buccal plate of mandible; MM, Masseter muscle; NG, Neural gutter.

By the time the neural or basal element is firmly established the tooth germs approach the bell stage of their development. To afford support and protection to the developing teeth a new bony element is added to the existing neural element, namely the alveolar plates. These appear from the outer and inner lips of the neural groove and push their way towards the oral epithelium, obviously influenced in their primary direction by the position of the developing teeth. A coronal section from a 44-mm. embryo (*Fig.* 5) emphasizes this new stimulus to mandibular development, for histologically the alveolar

plates are not merely a further extension of the walls of the neural groove but are seen to be a definite new addition to that structure.

In the same photograph the disproportion in size between the mandible and Meckel's cartilage is noticeable. The cartilage does not attempt to keep pace with the growth of the jaw, for it has already begun to outlive its useful purpose, which was to support the mandibular arch structures before bone development. Therefore it is soon resorbed and taken up into the substance of the mandible, by its calcification and replacement by bony tissue. This encroachment by the mandible is very active by the 75-mm. stage, beginning in the future canine region and spreading mesially and distally. *Fig.* 6 shows the irruption of osteoblastic elements into the substance of Meckel's cartilages and the changes taking place within them at the 75-mm. stage. This is a coronal section and both sides of the lower jaw are shown. As a result of the spread of resorption mesially it is possible that the most anterior part of Meckel's cartilage may remain unresorbed for a considerable period and be associated with pathological changes at the symphysis. The fate of the more posterior parts of Meckel's cartilage is well known—its contribution to

Fig. 5.—Coronal section through the mandible of a 44-mm. C.R. length human embryo. IAP, Inner alveolar plate; ID, Inferior dental nerve; MC, Meckel's cartilage; NG, Neural groove; OAP, Outer alveolar plate.

Fig. 6.—Coronal section through the anterior part of the mandibular region in a 75-mm. C.R. length human embryo showing resorption of Meckel's cartilages by mandibular bone.

the sphenomandibular ligament and two of the ear ossicles, the malleus and incus.

During subsequent mandibular development cartilage makes its appearance in other situations as a secondary phenomenon, in response to the stress of muscle attachment (in the coronoid and angular processes), the demands of growth (condylar process), or possibly local ischæmic conditions (alveolar processes).

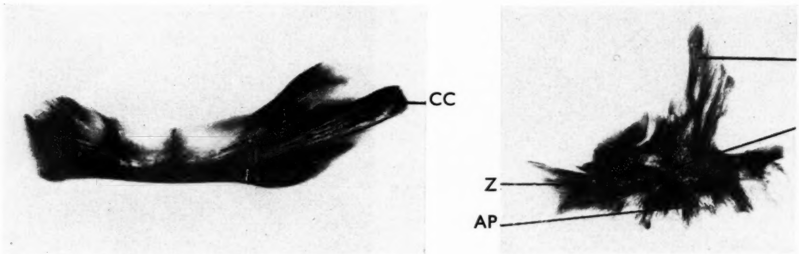
Nodules of alveolar secondary cartilage are of frequent occurrence in the canine and incisor region, being of a hypertrophic variety, and are customarily seen in embryos of more than 100-mm. C.R. length. The coronoid cartilage appears as early as the 44-mm. stage but has disappeared by birth. This applies also to the cartilage found at the angle of the mandible and which is less pronounced, for it is less subject to muscular stress and is probably best termed "chondroid bone" rather than undoubted cartilage. The condylar cartilage extends backwards, upwards, and laterally from the region of the future inferior dental foramen to the temporomandibular

joint as a cone-shaped mass typical of that found at the growing ends of long bones. It appears between the 40–50-mm. stage but by mid-term is replaced almost entirely by bone trabeculæ, except for its base which forms the articular surface of the mandibular condyle. Continuing to function as a growth cartilage until after the twentieth year it is responsible for much of the increase in length of the mandible.

By four and a half months the adult form of the mandible has been attained. To the basal (neural) element have been added alveolar, muscular, and cartilaginous processes. The bone is of the typical embryonic woven variety with little indication of compact layers. Radiographs of a mid-term mandible (*Fig.* 7 A) reveal both the cancellous nature of the bone, the trabeculæ radiating from the region of the centre of ossification, and the remarkably cancellous appearance of the now osseous growth cartilage.

DEVELOPMENT OF THE MAXILLA

It would be an interesting finding if the centre of ossification for the major bone of the upper jaw were situated in a position comparable to that existing in the mandibular process, as described above. This is indeed the case, for the maxilla begins its development in an exactly similar fashion in a nerve angle formed in this instance by the infra-orbital nerve and its anterior superior dental branch. The maxilla appears a little later than the mandible, a natural observation when one observes that the maxillary process is an offshoot from an already well-established mandibular process, and therefore tissue differentiation within it must necessarily occur at a later stage. Sagittal sections from a 25-mm. embryo (*Fig.* 8) show the relationships of the maxillary and mandibular divisions of the trigeminal nerve to the upper and lower jaw respectively. The trigeminal ganglion is a relatively enormous structure at this period of development.



A B

Fig. 7.—Microradiographs of the mandible (A) and maxilla (B) from a mid-term human fœtus. AP, Alveolar process; CC, Condylar cartilage (ossified); F, Frontal process; NE, Body of maxilla; Z, Zygomatic process.

The maxilla spreads rapidly from the single centre in several directions, upwards towards the cartilaginous nasal capsule as the frontal process, inwards into the substance of the now horizontal palatal folds as the palatal process, and downwards towards the outer side of the dental lamina as the outer alveolar plate. These modifications to the single centre of ossification are quite evident in embryos of 30–35-mm. C.R. length.

As in the case of the mandible the primary spread of maxillary bone is essentially to establish a neural groove which supports and contains the infra-orbital nerve. In sections from a 60-mm. embryo (*Fig.* 9) this groove is a prominent feature, its medial wall being closely related to the nasal capsule. Here, as in the mandible, the alveolar plates project from the body of the bone in response to the presence of developing tooth germs, the medial alveolar plate being a downgrowth from the root of the wedge-like palatal process.

The close relation of the maxilla to the cartilaginous skeleton of the nasal capsule is more striking in sections cut in the horizontal plane, when the bone is seen to be closely applied to the lateral surface of the capsule for the greater part of its antero-posterior length, strikingly reminiscent of

Fig. 8.—Sagittal section from a 25-mm. C.R. length human embryo showing the relationships of the developing jaws to the divisions of the trigeminal nerve. ASD, Anterior superior dental nerve; IO, Infra-orbital nerve branches; MA, Mandible; MAX, Maxilla; MC, Meckel's cartilage; MD, Mandibular division; MX, Maxillary division; TG, Trigeminal ganglion.

the conditions in the lower jaw. These observations suggest that the primary cartilaginous skeleton of the jaws and the developing teeth determines the fundamental form of the face, to be modified later by functional activity. By means of a diagram (*Fig.* 10) and a table (*Table I*) it is possible to summarize

Table I.—Structures related to the Developing Jaws

Mandible	Maxilla
Inferior dental nerve	Infra-orbital nerve
Meckel's cartilage	Nasal capsule
Tooth germs	Tooth germs

the early development of the jaws and to indicate the direct comparisons between them in their relationships to surrounding structures.

Whereas the mandible receives a major contribution from the appearance of accessory or secondary cartilages, the maxilla is almost entirely devoid of cartilage in its development. A small site regularly appears at the root of the zygomatic process about the 44-mm. stage, but only persists for a short time. This alternative to bone formation may be due to ischæmic conditions, as in the alveolar plates in the mandible, or to localized demands

Fig. 9.—Coronal section through the maxillary region in a 60-mm. C.R. length embryo. AP, Medial alveolar plate; NC, Nasal capsule; NG, Neural groove; P, Palatal process.

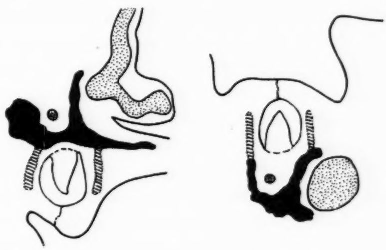


Fig. 10—Diagram comparing the developmental parts of the maxilla (on the left) and mandible. Solid black shows the neural groove; Hatching, alveolar plates; Stipple, cartilage.

for rapid growth. Although of much less importance to the subsequent development of the maxilla, the appearance of cartilage enables a further comparison of the developmental elements in both jaws to be made, again stressing the outstanding basic similarities in the early development of these bones. This is represented in tabular form (*Table II*).

Maxillæ from mid-term fœtuses are thus made up of a body, alveolar, frontal, zygomatic, and palatal processes, and radiographs

show ideally the radiation of bone trabeculæ from the centre of ossification; yet another comparison between maxillary and mandibular development (*Fig.* 7 B).

Table II.—DEVELOPMENTAL ELEMENTS

MANDIBLE	MAXILLA
Neural	Neural
Alveolar	Alveolar
Ramal	Zygomatic
Muscular	Palatal
Cartilaginous	Cartilaginous

DEVELOPMENT OF THE PALATINE BONE AND THE PREMAXILLA

The maxilla forms the major part of the upper jaw, but is added to from behind by the palatine bone, and in front by the premaxilla.

The palatine bone, like the maxilla, develops in membrane in relation to the nasal capsule and, in this instance, to the sphenopalatine branches of the maxillary nerve. It is less striking in its development because of its lack of relationship to developing dental structures.

Of much greater interest and importance is the premaxilla, which is customarily defined as the bone of the upper jaw which carries the incisor teeth. However, considerable controversy has centred around this bone for many years, a number of authors doubting its existence in Man. This is an opportune occasion to discuss some of the evidence concerning its differentiation.

In all primates other than Man there is no doubt of the existence of the premaxilla, which remains evident throughout life on the facial aspect of the skull, a well-marked suture separating the premaxillary and maxillary elements. Thus the narial margins are formed entirely by the alveolar and frontal processes of the premaxillæ. In Man there is no evidence on the facial aspect of the skull of a premaxilla-maxillary suture, the only possible indication of its existence being on the anterior part of the hard palate where small sutures, which pass laterally towards the lateral incisor or canine tooth, are usually taken to be visual evidence of the premaxilla-maxillary junction.

It has been suggested by a number of workers including Callender (1869), Wood-Jones (1947), and Woo (1949) that in early embryonic life the maxilla grows forward over the premaxilla and by meeting the opposite maxilla (forming the "maxillary clip") the premaxilla is buried completely on the facial aspect. Hence the sockets for the incisor teeth are formed labially by the maxilla, lingually by the premaxilla, and the narial margins are of maxillary origin.

Recently an earlier contention by Frazer (1946) that the premaxilla is non-existent in Man has been revived by Jacobson (1955) based on embryological evidence. These authors maintain that the so-called palatal incisive suture is not a true suture but the remains of a bay or recess in the medial border of the palatal process of the maxilla, induced by the presence of the nasopalatine duct, associated vessels, and nerves.

The non-existence of the premaxilla would fit in well with the conception of the development of the jaws presented here, for a single unit on each side of the upper as well as the lower jaw would be even more suitable for direct developmental comparisons. However, the evidence from available embryological material is confusing. Histologically, embryos from 15–30 mm. in C.R. length support, in a number of instances, Jacobson's findings of complete bony continuity from the centre of ossification of the maxilla to the midline, with no definite evidence of separate ossific centres. Individual sections may show a slight break in continuity but when due consideration is given to serial sections this is sometimes found to be misleading. The only real evidence for distinction between maxillary and premaxillary elements seems to be the sharp line of demarcation between fully formed bone trabeculæ (maxilla) and a more recent osteoid stage (premaxilla) which is often apparent in these early embryos (*Fig.* 11). The osteoid is more palely stained than the calcified bone.

Naked-eye examination of the fœtal maxillæ suggests the existence of the premaxilla, for

on the medial aspect of the frontal process a well-defined suture-like groove passes vertically downwards towards the palate and is continuous there with a suture which terminates at the incisive foramen. The presence of a fissure of this extent is denied by those who favour the non-existence of the pre-maxilla.

Fig. 11.—Horizontal section through the maxillary region of a 25-mm. C.R. length human embryo. ASD, Anterior superior dental nerve; M, Maxilla; O, Oral cavity; PM, Premaxilla.

Then again certain abnormal skulls strongly suggest that a premaxilla is present in Man, and Derry (1938) described two adult skulls in which he suggested that this bone had failed to develop. Finally, although one must be aware of the pitfalls in relating comparative to human anatomy it seems unreasonable that the premaxilla should be a constant feature of mammalian skulls, even in the remaining members of the primates, and yet to have disappeared abruptly and entirely in Man, even allowing for his remarkable lack of dental specialization.

One of the important applications of the concept of the premaxilla is to the aetiology of cleft palate and lip. Unilateral and complete bilateral jaw–lip clefts appear to be more readily explained on the basis of lack of fusion of maxillary and frontonasal processes with consequent separation of bony elements and teeth contained within them, although the variable position of the lateral incisor to the unilateral cleft remains difficult to explain. The summation of evidence as far as one is concerned at present favours, in normal development, extremely rapid fusion of a nevertheless potentially separate maxilla and premaxilla.

Henceforth, the development of the jaws, by which process all the constituent parts of the jaws are acquired, is superseded by growth or increase in size, the one process merging imperceptibily into the other. At first all parts undergo active enlargement but soon this is limited to certain sites where growth takes place in three ways: (1) growth of cartilage and its replacement by bone; (2) surface deposition of bone; and (3) growth at sutures.

CLINICAL APPLICATIONS

The principles of jaw development may be applied to clinical dentistry and these will be dealt with briefly.

1. It has been shown that the teeth are supported by alveolar bone which develops expressly for this purpose. In orthodontic practice alterations in pressure upon teeth promote cellular modulations in the labile alveolar bone which consequently adapts itself readily to altered tooth position, a modification most easily carried out during the growing period.

On the other hand, the basic neural element develops for quite a different purpose—to support nervous tissue—and one would not expect this part of the jaws to respond to tooth movement. The critical region of dento-facial development seems therefore to lie between the alveolar bone and the basal bone which supports it.

When teeth are lost from the dental series alveolar bone no longer serves a useful function and is resorbed. This is further evidence of the distinction between the primary jaw elements and is, of course, of special importance in prosthetic dentistry.

2. A knowledge of jaw development helps to elucidate certain pathological features.

a. Cleft palates and lips have been mentioned earlier; essentially they are the result of a failure of union or secondary breakdown of embryonic soft tissue processes.

b. The most likely sites for cartilaginous tumours of the jaws can be anticipated, and agree well with clinical observations. This does not imply that fœtal cartilage necessarily

persists into adult life, but that certain cells may well retain a potentiality to produce cartilage matrix under certain circumstances. Alternatively, the close relationship of the primary cartilaginous skeleton (nasal capsule or Meckel's cartilage) to the developing jaws may be another source of cartilaginous foci, in the form of remnants of these structures.

c. The greater dependence of the mandible on growth by cartilage replacement accounts for the overgrowth of the lower jaw compared with the upper facial skeleton in acromegaly. Conversely, the dystrophy affecting membrane bones which are not dependent on cartilage replacement, namely, cleidocranial dysostosis, primarily affects the maxillary region.

SUMMARY

The early development of the jaws is described with emphasis on a comparison of their developmental patterns. It is suggested that at least two important concepts emerge from this paper.

1. The jaws should be considered as a unit in the developmental as well as in the functional sense; for beginning their existence in derivatives of the mandibular arch they are induced to develop in accordance with certain related structures which are comparable in both jaws. These are the dental nerves, cartilaginous elements, and the dental lamina and tooth germs.

2. Far from being a mere academic exercise this problem has a bearing on a number of specialized branches of clinical dentistry.

Acknowledgements.—I wish to record my thanks to Mr. P. Howarth and Mr. D. W. McKears for their assistance in the preparation of the photomicrographs and microradiographs respectively.

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DISCUSSION

Dr. W. R. Burston said that it gave him great pleasure to open the discussion on Mr. Dixon's paper which he had found quite fascinating. As the Chairman had recalled, Mr. Dixon belonged to that noble band of morphologists who sprang from that outpost of the Empire, Belfast! Everyone working in orthodontics and allied fields must be grateful that a certain number of morphologists were taking dentistry and in particular dental development under their wing. Manchester—not only students but orthodontists also—were very fortunate in having Mr. Dixon's able support.

Mr. Dixon had commenced by mentioning growth and development and his object was, of course, to circumscribe his paper and keep it within limits. He was thus using "development" in the restricted sense common to embryology, but as far as the jaws were concerned development did in fact continue long into post-natal life—a fact which made orthodontics the interesting study it was. Seriously, he thought the problem of development, extending some of Mr. Dixon's remarks a little further, permitted slightly different interpretations.

He had been very interested in what Mr. Dixon had said about the formation of the facial processes, and, in so far as the primitive palate was concerned, to what degree epithelial fusion was involved.

With the extreme shortage of cleft-palate human embryos, and for that matter a close series of normal embryos, the matter could not be regarded as settled. He himself tended to follow Streeter's view in regarding a cleft of the primary palate (harelip and alveolar cleft) as arising primarily by breakdown consequent on the failure of the mesodermal maxillary process to extend far enough towards the midline. One of the advantages of this view was that it provided an explanation—possibly too facile an explanation—of the aetiology of this kind of cleft and also explained the variability of the position of the cleft. In this context it must be remembered that the respiratory by-pass which defines the primitive palate was complete by about five weeks, whereas the ossification of the premaxillary-maxillary complex was a later phenomenon. Mr. Dixon might like to clarify these points a little further.

Neural induction was a fascinating field for the experimental embryologist. It was true of course that neural development played a vital role in the early development of the embryo. It would be recalled that modern theory now held that the facial mesoderm was derived directly from neural crest material. However, the suggestion that, at a much later stage, peripheral nerves were responsible for the induction of membrane bone was, he thought, a new suggestion and quite fascinating. Clearly the problem was difficult in amniotes because the experimental approach was fraught with technical difficulties. It was true, of course, that as far as the head was concerned membrane bone was usually found in association with a leash of nerves, e.g., parietal

and frontal bones. However, it was difficult to reconcile Mr. Dixon's thesis with the view of the classical morphologists when one thought of the phylogeny of these bones. The complex structure of the reptilian skull came to mind where it would be difficult to explain the induction of these bones on the above theory. Another difficulty arose in considering teratoma, where one found dental derivatives and undoubted membrane bone forming not in association with nerves in the way Mr. Dixon had described.

Then there was the question of the neural elements of the maxilla and mandible considered as the "basal elements" of these bones. Here care was necessary because orthodontists had introduced their own term "basal bone" with a different connotation. It was some sort of recognition that there were areas of the maxilla and mandible outside normal orthodontic procedures. Now the anatomists were using the term and ascribing to it definite landmarks.

It would appear that in orthodontic usage the region called basal bone is not constant, but increases as the jaws grow. From the practical standpoint there was in this an argument for the early correction of a malocclusion in order to avoid leaving behind an area of deformed bone which could no longer be altered.

Using the term "basal" or "neural element" in the way defined by Mr. Dixon, he was in agreement that these structures combined to form a functional unity. This was achieved by virtue of the fact that both maxilla and mandible were originally developed in close association with the primordial cartilage of the chondrocranium. Mr. Dixon had rightly made a very close comparison between the mandible and the maxilla from this standpoint.

This importance of primordial cartilage, as a spatial regulating mechanism between the jaws, was seen best in lower forms, e.g., the reptiles, where Meckel's cartilage persisted for a long time. Since this cartilage articulates with the otic capsule and hence with the cranial base (which includes the nasal septum), any growth of cartilage must influence jaw relationship.

The mammalian mandible was unique. Most people would agree that it corresponded with the dentary of the reptile. However, the interesting thing was that mammals had this unique trick of cutting off the upper end of Meckel's cartilage to form the ossicles of the ear. At that time the mandible developed its condylar cartilage and this cartilage took over the task of maintaining the spatial relationship of the jaws, and for this reason the condylar cartilage was unique amongst secondary cartilage occurring elsewhere in the jaws.

He therefore reached complete agreement with Mr. Dixon regarding the functional unity of the jaws via cartilage, but wondered how much further one could take the analogy between the two jaws. Regarding the premaxilla and the maxilla, the independence or otherwise of these bones had been a happy hunting ground for many years. Fallopius in the sixteenth century had been the first to describe the inter-canine suture of the palatal surface. The whole problem revolved round the method of examination that was employed and this was particularly true of human material. Human specimens were very difficult to obtain in good condition and in anything like a sufficiency of numbers to get a close series. One tended to employ the histological method of examination in such valuable specimens so as to have the best of all worlds. However, the trouble with these serial sections was that it was very difficult to identify bands of condensation and the margins of early bone and cartilage formation. In the early stages so much depended on the staining technique and minor variations would produce profound differences in subsequent appearance and interpretation.

The history of cranial morphology abounded in contentious argument based on such conflicting evidence, and in general the histological method was now recognized as unreliable in the identification of independent morphological units.

Very recently, in order to obtain some quick information, he had resorted to the rather out-of-date method of bulk-staining a human specimen, cleaning it, and examining it *in toto* under a stereobinocular microscope. In these circumstances, although he would not claim to have made a complete identification, the appearance indicated that the premaxilla and maxilla coexisted as two independent elements.

He was very appreciative of the lecture and thanked Mr. Dixon very much.

The Chairman (*Professor Ballard*) said he would like to make one observation on which Mr. Dixon could comment if he liked. It related to cleft palates from the clinical point of view. He tended to agree with those who believed it was lack of fusion and not a breakdown. Looking at clefts radiographically, there appeared to be a quite obvious deficiency of bone. It was probably a deficiency, in early development, which resulted in failure of fusion.

In particular, one could not help noticing radiographically in the premaxilla region, that the bone which orthodontists would call the basal bone appeared to be entirely absent. In the proboscis Mr. Dixon had shown he would say that the bone was alveolar bone.

If one tried to move teeth across the cleft to stimulate bone in the root region, one failed completely and produced root resorption. That was his experience.

The paper was now open for general discussion.

Mr. J. R. E. Mills said he must congratulate Mr. Dixon on his extremely lucid exposition.

Mr. Dixon had drawn attention to the early closure of the suture between the maxilla and premaxilla in man as compared with the great apes. This was associated with another difference between the two groups; in the apes there was a large canine with a diastema between this and the lateral incisor. Growth was necessary to produce sufficient room for these two features, but corresponding growth was not necessary in man where the canine was small and there was no diastema. Was it possible that the persistent suture in the apes was associated with this increased need for growth?

Mr. Mills remembered, some years ago, examining a large series of ape skulls and his impression was that in female chimpanzees, where the canine was comparatively small, this suture closed at an early stage.

Mr. W. J. Tulley said that he had never heard so lucid an explanation of these aspects of development.

One thing that he would disagree with was the expression "abnormal growth" in one area or another. In most orthodontic cases, one was not dealing with abnormal growth in any one part but with an overall genetic pattern of growth.

The Chairman (*Professor Ballard*) said he must admit to having been shocked by the words "abnormal growth" but thought it was not for him to comment from the Chair. He supported Mr. Tulley's remark.

Mr. Dixon, in reply, thanked members for their kind remarks.

As to the words "abnormal growth", he had, of course, dropped in a few expressions like that in the hope that they would lead to discussion. There was continual discussion about what was normal and what was not normal, and he would not attempt to enter into it at all.

He agreed to a great extent with what Dr. Burston had said about the subdivision of growth and development; whether or not development was thought of as going on into adult life was really a matter of personal preference. Looking at the aspect from which he himself had treated the matter, he liked to think of development as the stage from the beginning to the time when all the bits and pieces were present. Then one went on to growth, when the bits and pieces grew in size but there was no further addition of any new element to the mandible or maxilla. Therefore, he considered development as that fairly definite stage when the "alphabet" was laid down. When the "alphabet" had been laid down one could increase the size of the letters as much as one liked—that was growth.

With regard to the development of cleft lip and palate, failure in the fusion of facial processes and the failure of the maxillary process to grow round was the usual view and one he held himself. The primitive palate was formed by the lower part of the frontonasal process, and the maxillary shelves grew in and fused with it.

The Chairman had brought out very well the point about fusion, but the difficulty was that, as Jacobson had pointed out, the bone may not hold to the boundaries of its own embryonic process. In other words, it could grow right through into a neighbouring mesodermal process and there was not a line of fusion showing at this stage. It was a difficult problem and largely due to the premature fusion of the soft tissues before the ossification centres appeared.

Some interesting remarks had been made about neural induction. If it had been possible, it would have been interesting to investigate it in animals with amniotic cavities; but one had not only to go through the uterus but through the amnion which released fluid, and the embryo frequently aborted. This was the kind of difficulty which prevented him from tackling it himself.

He had not tackled anything much lower than Man in the evolutionary scale or pattern, primarily because he thought one could not relate anything to human development that would be accurate experimentally apart from primates or something very near to primates, because of different morphological features.

Another thing which put one off experimentation, if one thought about it, was how to show that one had not just produced an abnormal result. If one damaged the connective tissues of the soft embryonic processes as well as nervous tissue the result was not necessarily due to the destruction of the nerve but to coincident damage to the surrounding area or possibly upset of the ossification process. Teratomata were extremely abnormal productions and could hardly be related to normal bone development.

He had used the term "basal bone" because he also thought of it as an orthodontic term and not particularly as a developmental one. In his own mind he related the neural element to the subsequent basal element because the basal bone was the bone that had been derived essentially from that neural element in the embryo, just as the alveolar bone in the adult was derived from the alveolar processes of the embryo. He liked to think of these elements as being clearly distinct from one another.

Dr. Burston was a tremendously keen morphologist, as members were aware, like himself to some extent. He would not go back to reptiles for reasons that were now obvious. He was specifically concerned with human development and therefore left out other forms. But he agreed entirely that the important point was that primary cartilage formed independently from the jaws. The secondary cartilage was a localized phenomenon. It meant other bony processes were to be shot out in this or that direction or that there might not be a good enough blood-supply at a particular time. It was quite subsidiary.

Histologically, there was no doubt that the premaxilla was a difficulty. It was interesting that the two separate elements could be seen under the dissecting microscope. Undoubtedly, the whole thing turned on the fact that one could not get enough of the very early embryos or if one did they were often damaged in some degree. That was a major reason for the continued controversy.

Professor Ballard's question about radiological appearances of clefts was quite new to him and he did not know very much about it. It was very interesting, for if the alveolar bone was present in the proboscis, where did it come from? Would it still be derived from the premaxillary element or an overgrowth of maxillary element, and if so how did one argue against Wood-Jones and others? How did one get over the difficulty that many people maintained that the lingual alveolus was premaxillary and the buccal maxillary? If it was alveolar bone, what bone was it derived from? It must be one or the other.

In reply to Mr. Mills, there had not been enough skulls of primates or female apes to examine to find out whether the suture was absent or not. He had never noted its absence himself but it was well worth going into.

With regard to the diastema, in many of these animals it was negligible in size. Not a great deal of diastema was present in some of them, and yet there was a very well defined premaxilla-maxillary suture. The presence of the suture did not seem to imply growth in every case.

The Chairman assured Mr. Dixon that it was not due to lack of interest that so few people had taken part in the discussion. It did members of the Society a lot of good to hear someone go over the ground that he, at any rate, should have remembered from his undergraduate days, particularly when it was put so lucidly that he could understand what he was told. It also did them a lot of good to have these new views put forward, particularly if they seemed to support clinical observations. He had pleasure in thanking Mr. Dixon and also Dr. Burston for opening the discussion.